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Alluvial Valley Floors in East-Central Montana and Their Relation to Strippable Coal Reserves - A Reconnaissance Report

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ALLUVIAL VALLEY FLOORS IN EAST-CENTRAL MONTANA AND THEIR RELATION TO STRIPPABLE COAL RESERVES

RECONNAISSANCE REPORT

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ABSTRACT

This reconnaissance study indicates that small percentages of strippable coal underlie the valley floors of east central Montana. Extensive coal reserves underlie upland areas and small tributary streams. Valley floors serve an important role in the local economy and are the most productive lands of the region. They are primarily high-quality sources of range forage and secondarily produce harvestable hay crops.

This work supports conclusions of previous investigators in demonstrating that the quasi land use category of alluvial valley floors can be mapped by combining topographic maps, selected aerial photography, and reconnaisance field work. This work identifies the alluvial valley floor as a part of a larger mappable geologic unit which includes the alluvial deposits extending out from the alluvial valley floors and likely important to those alluvial valley floors by virtue of hydrologic interdependence. Included within these "related alluvial deposits" are "wildlife areas" which extend upstream from mapped alluvial valley floors.

Various characteristics of valley floor areas were mapped and vegetation was investigated along several transects in the Burns Creek-Thirteenmile Creek KCLA and in the Redwater River area. These data show that valley floors support distinctive vegetative communities (species lists are included in the report) and produce the most forage of any range sites in the area. Soil salinity is the most important factor limiting use of valley floors, particularly in McCone and eastern Garfield Counties, and also may pose a significant challenge to reclamation.

Stream channels, floodplains, and low terraces were mapped as alluvial valley floors in those valleys used for hay production or which appeared to have the potential for such use. Alluvial valley floors overlie 1.5 percent of the tonnage of high potential development coal reserves of the Burns Creek-Thirteenmile Creek Known Coal Leasing Area (KCLA), Dawson and Richland Counties; 2.4 percent of the tonnage of the Weldon-Timber Creek strippable coal deposit, western McCone County; and 8 percent of the tonnage of the Redwater River strippable coal deposit, eastern McCone County. Mapping of the more extensive high terraces along alluvial valley floors in the Burns Creek-Thirteenmile Creek KCLA and the Redwater River deposit show that about twice as much coal underlies the total alluvial deposit area than underlies the more restrictively defined alluvial valley floor. If mining were excluded in the total alluvial valley floor area, an even greater percentage of reserves would be made unavailable because of the impracticality of developing logical mining units. Despite this fact, extensive strippable coal reserves exist outside of valley floor areas in each area studied in this report.

While it remains evident that more detailed hydrologic, geologic, and engineering work is necessary to identify the specific impacts of a mining operation on a particular valley floor, this effort shows that it is possible to use reconnaissance methods to identify and map those valley floors of agricultural and hydrologic significance. Future reconnaissance mapping efforts should focus on valleys used in part for hay production since most all alluvial valley floors mapped in this study contain some areas of hay production. It is estimated that 25 percent of all mapped alluvial valley floors were in hay production at the time of the field investigations. Those areas mapped as related alluvial deposits included most of the remaining hay lands.

TABLE OF CONTENTS

Page

Abstract i

List of Tables ....v.

List of Figures ....vi.

List of Plates ....viii.

Introduction 1

Previous Work 4

Method of Investigation 8

Mapping Unit Definitions and Application 12

Coal Data 16

Physiographic Description of Study Areas 17

Estimates of Area Involved and Coal Resource Underlying Alluvial Valley Floors 18

Valley Floor Characteristics Identified 28

- Vegetation 29
- Saline Areas 35
- Gravel Areas 35
- Hayed Lands 35
- Property Value 37

Conclusions 38

Acknowledgements 40

Bibliography 41

Appendices

- Area 1. Burns Creek-Thirteenmile Creek KCLA A-1

TABLE OF CONTENTS (continued)

Page

Area 2. Weldon-Timber Creek Deposit A-40

Area 3. Redwater River Deposit A-51

Area 4. Eastern Garfield County A-70

Common and Scientific Names of Vegetation Found in Study Area A-77

TABLES

Page

1. Study Areas and Locations 7

2. Sources of Air Photos Used for Mapping 11

3. Tons of Coal Underlying Alluvial Valley Floors and Related Alluvial Deposits - Burns Creek - Thirteenmile Creek KCLA 21

4. Area of Alluvial Valley Floors and Related Alluvial Deposits Overlying Coal Reserves - Burns Creek - Thirteenmile Creek KCLA 22

5. Area of and Coal Tonnage Underlying Alluvial Valley Floors - Weldon-Timber Creek Deposit 24

6. Area of and Coal Tonnage Underlying Alluvial Valley Floors - and Related Alluvial Deposits - Redwater River Deposit 26

7. Summary of plant coverage data for partially to quite saline alluvial terraces near Nelson Creek, McCone County 32

LIST OF FIGURES

Page

1. Locations of Study Area 3
2. Study Area Showing General Location of Alluvial Valley Floors and Indicating Location of More Detailed Maps 9
3. Location of Alluvial Valley Floors and Related Features - Clay Butte Quadrangle, MT A-3
4. Location of Alluvial Valley Floors and Related Features - Bloomfield Quadrangle, MT A-4
5. Location of Alluvial Valley Floors and Related Features - Enid SE Quadrangle, MT A-5
6. Location of Alluvial Valley Floors and Related Features - Red Top Quadrangle, MT A-6
7. Location of Alluvial Valley Floors and Related Features - Butler Table Quadrangle, MT A-7
8. Location of Alluvial Valley Floors and Related Features - Intake NW Quadrangle, MT A-8
9. Location of Alluvial Valley Floors and Related Features - McCone Heights Quadrangle A-9
10. Location of Alluvial Valley Floors and Related Features - Allard Ranch Quadrangle, MT A-10
11. Location of Alluvial Valley Floors and Related Features - Larson School Quadrangle, MT A-11
12. Location of Alluvial Valley Floors and Related Features - Knife River Mine Quadrangle, MT A-12
13. Location of Alluvial Valley Floors and Related Features - Crane Quadrangle, MT A-13
14. Location of Alluvial Valley Floors and Related Features - Hedstrom Lake NW and Hedstrom Lake Quadrangles, MT A-73
15. Location of Alluvial Valley Floors and Related Features - Tree Coulee School and Hedstrom Lake SE Quadrangles, MT A-74
16. Location of Alluvial Valley Floors and Related Features - Little Chalk Butte and Crow Rock Quadrangles, MT A-75
17. Location of Alluvial Valley Floors and Related Features - Rock Springs School and Crow Rock SE Quadrangles, MT A-76
18. Transect A-A' South Fork Burns Creek A-28
    (Location shown on Plate 25, Intake NW)
19. Transect B-B' Middle Fork Burns Creek A-29
    (Location shown on Plate 27, Allard Ranch)
20. Transect C-C' North Fork Burns Creek A-30
    (Location shown on Plate 26, McCone Heights)
21. Transect D-D' North Fork Burns Creek A-31
    (Location shown on Plate 24, Butler Table)
22. Transect E-E' North Fork Burns Creek A-32
    (Location shown on Plate 24, Butler Table)
23. Transect F-F' Middle Fork Burns Creek A-33
    (Location shown on Plate 22, Enid SE)
24. Transect G-G' North Fork Thirteenmile Creek A-34

LIST OF FIGURES (continued)

Page

(Location shown on Plate 20, Clay Butte)
25. Transect H-H' North Fork Thirteenmile Creek.................... A-35
(Location shown on Plate 20, Clay Butte)
26. Transect I-I' South Fork Burns Creek............................ A-36
(Location shown on Plate 22, Enid SE)
27. Transect J-J' Crane Creek....................................... A-37
(Location shown on Plate 28, Larson School)
28. Transect K'K' Dunlap Creek...................................... A-38
(Location shown on Plate 30, Crane)
29. Transect L-L' Sears Creek....................................... A-39
(Location shown on Plate 30, Crane)
30. Transect M-M' Redwater River.................................... A-66
(Location shown on Plate 13, Lost and Buffalo Springs Creeks)
31. Transect N-N' Redwater River.................................... A-67
(Location shown on Plate 10, Timber and Dry Ash Creeks)
32. Transect O-O' Redwater River.................................... A-68
(Location shown on Plate 10, Timber and Dry Ash Creeks)
33. Transect P-P' Horse Creek....................................... A-69
(Location shown on Plate 13, Lost and Buffalo Springs Creeks)

LIST OF PLATES

Plate Page

1 Location of Alluvial Valley Floors and Related Features - A-43
Timber Creek Aerial Photograph, MT.............................. A-43

2 Location of Alluvial Valley Floors and Related Features -
Skull and Timber Creeks Aerial Photograph, MT................ A-44

3 Location of Alluvial Valley Floors and Related Features -
Nelson Creek (West) Aerial Photograph, MT.................... A-45

4 Location of Alluvial Valley Floors and Related Features -
Skull Creek Aerial Photograph, MT............................ A-46

5 Location of Alluvial Valley Floors and Related Features -
McGuire Creek Aerial Photograph, MT.......................... A-47

6 Location of Alluvial Valley Floors and Related Features -
Nelson Creek (East) Aerial Photograph, MT.................... A-48

7 Location of Alluvial Valley Floors and Related Features -
Dirty Creek Aerial Photograph, MT............................ A-49

8 Location of Alluvial Valley Floors and Related Features -
Horse and Prairie Elk Creeks Aerial Photograph, MT........... A-50

9 Location of Alluvial Valley Floors and Related Features -
Horse Creek Aerial Photograph, MT............................ A-54

10 Location of Alluvial Valley Floors and Related Features -
Timber and Dry Ash Creeks Aerial Photograph, MT.............. A-55

11 Location of Alluvial Valley Floors and Related Features -
Cow Creek (West) Aerial Photograph, MT....................... A-56

12 Location of Alluvial Valley Floors and Related Features -
Buffalo Creek Aerial Photograph, MT.......................... A-57

13 Location of Alluvial Valley Floors and Related Features -
Lost and Buffalo Springs Creeks Aerial Photograph, MT........ A-58

14 Location of Alluvial Valley Floors and Related Features -
McCune Creek Aerial Photograph, MT........................... A-59

15 Location of Alluvial Valley Floors and Related Features -
Cow Creek (East) Aerial Photograph, MT....................... A-60

16 Location of Alluvial Valley Floors and Related Features -
Duck and Spring Creeks Aerial Photograph, MT................. A-61

17 Location of Alluvial Valley Floors and Related Features -
Cottonwood Creek Aerial Photograph, MT....................... A-62

18 Location of Alluvial Valley Floors and Related Features -
Berry Creek Aerial Photograph, MT............................ A-63

19 Location of Alluvial Valley Floors and Related Features -
Bluff Creek Aerial Photograph, MT............................ A-64

20 Location of Alluvial Valley Floors and Related Features -
Clay Butte Orthophoto Quadrangle, MT.........................A-16

21 Location of Alluvial Valley Floors and Related Features -
Bloomfield Orthophoto Quadrangle, MT.........................A-17

22 Location of Alluvial Valley Floors and Related Features -
Enid SE Orthophoto Quadrangle, MT............................A-18

LIST OF PLATES (Continued)

Plate Page

23 Location of Alluvial Valley Floors and Related Features - Red Top Orthophoto Quadrangle, MT.......................... A-19
24 Location of Alluvial Valley Floors and Related Features - Butler Table Orthophoto Quadrangle, MT...................... A-20
25 Location of Alluvial Valley Floors and Related Features - Intake NW Orthophoto Quadrangle, MT......................... A-21
26 Location of Alluvial Valley Floors and Related Features - McCone Heights Orthophoto Quadrangle, MT.................... A-22
27 Location of Alluvial Valley Floors and Related Features - Allard Ranch Orthophoto Quadrangle, MT...................... A-23
28 Location of Alluvial Valley Floors and Related Features - Larson School Orthophoto Quadrangle, MT..................... A-24
29 Location of Alluvial Valley Floors and Related Features - Knife River Mine Orthophoto Quadrangle, MT.................. A-25
30 Location of Alluvial Valley Floors and Related Features - Crane Orthophoto Quadrangle, MT............................. A-26

INTRODUCTION

Preservation of the hydrologic and agricultural integrity of valley floor areas in the semi-arid western United States has been an important concern to government officials, local ranchers, and the coal mining industry since the beginning of large scale coal strip mining in the late 1960's. The United States Congress has debated the merits of excluding mining activities in "alluvial valley floors" in each of its sessions since 1974, and the Montana State legislature considered a similar action in 1975. The Coal Mine Operating Regulations adopted in 1976 by the Department of the Interior state in part that a mine operator shall utilize the best practicable commercially available technology to minimize, control, or prevent disturbances to the hydrologic system by procedures including:

> "Protecting the quality, quantity, and flow, including depth of flow, of both upstream and downstream surface and ground water resources of thos valley floors which provide water sources that support significant vegetation or supply significant quantities of water for other purposes, by such measures as relocating and maintaining the gradients of streams, avoiding mining, installing, reestablishing, or replacing aquifers or aquicludes, and replacing soil..."
>
> Title 30 Code of Federal Regulations, Part 211.40(a)(7)(iv)

Although to date (January, 1977) no further action has been taken by the Federal government or any of the states, concern over this issue has continued to be expressed (Catterall, 1976). It may be reasonably speculated that national legislation will, quite soon, address the issue of alluvial valley floors in the western United States.

Two major issues have characterized the "alluvial valley floor" debate. One issue has centered on the importance, characteristics, and areal extent of these valley floors. Only recently has there been a public awareness that subirrigated valleys may provide sufficient forage to carry a ranching operation through dry periods and winter. The other issue has involved definition of the relationship of "alluvial valley floors" to the western coal resource and the impact of restricting mining of alluvial valley floors. This second issue may consist of two phases of impact. The first and always present phase of conflict or impact is the removal of agricultural use of the alluvial valley floor during coal mining. The second phase, and the phase of greatest concern, is that of permanent change of the geohydrologic character of the alluvial valley floor after mining when such change results in long-term (post-mining) loss of the agricultural use of the land, principally because of the loss of ability to effectively subirrigate grasses for hay production.

This report is the result of reconnaissance field work and air photo interpretation conducted during late summer and fall, 1976. The chief purpose of the project was the preliminary assessment of the impact of a prohibition against mining alluvial valley floors on the coal resources of portions of Dawson, Garfield, McCone, and Richland Counties, Montana (See Figure 1). A secondary purpose was the assessment of some of the physical and land use characteristics of these areas, and their importance to the local farming and ranching economy. Field work, data compilation, and report preparation were accomplished in less than five months. Thus, it must be emphasized that the report is reconnaissance in nature. The report is no substitute for site specific field work related to a particular mining proposal, which should document ground water levels, surface and subsurface soil and water salinity, aquifer relationships, the economic importance of a particular valley floor to individual ranchers and farmers, and identify specific mining and reclamation problems.

Four parts of the four-county area were studied. These are designated as Area 1 (Burns Creek-Thirteenmile Creek KCLA), Area 2 (Weldon-Timber Creek Deposit), Area 3 (Redwater River Deposit) and Area 4 (Eastern Garfield County). Sufficient coal resource data exist for the first three areas to permit the preliminary assessment of the amount of coal underlying the alluvial valley floors. Area 4 ("Eastern Garfield County", which includes a small portion of McCone County*) encompasses areas nominated for future coal leasing as a part of the Department of Interior's EMARS (Energy Minerals Activity Recommendation System) process (Superintendent of Documents, 1976) and quantitative coal resources data are not available. Figure 1 and Table 1 provide the location and correlation of the areas with counties in Montana and with the available coal data.

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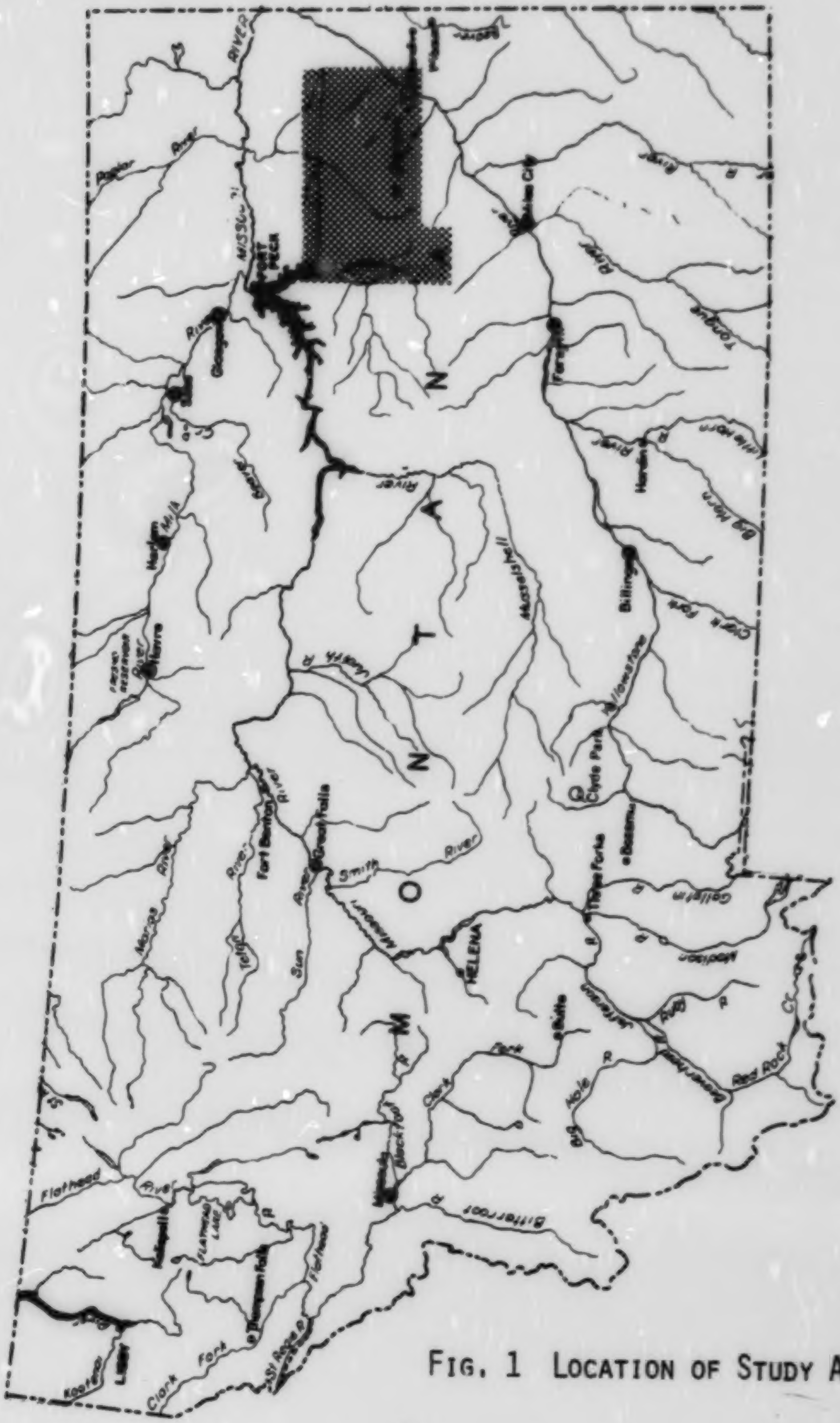
* Alluvial valley floors were not mapped in the McCone County portion of Area 4.


M
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A
MISSOURI RIVER
FORT PECK
Poplar River
Milk
Havre
Great Falls
Fort Benton
Sun River
Smith River
Teton River
Marias River
Musselshell
HELENA
Three Forks
Gallatin R
Madison R
Jefferson
Butte
Big Hole R
Red Rock
Clark Fork
Missoula
Blackfoot
Bitterroot R
Flathead River
Flathead Lake
Kalispell
Libby
Kootenai
Thompson Falls
St Regis R
Billings
Yellowstone
Clyde Park
Bozeman
Big Horn
Hardin
Forsyth
Miles City
Tongue
Clark Fork

Fig. 1 Location of Study Area ▨

PREVIOUS WORK

The House Committee on Interior and Insular Affairs (1976) discussed the definition of "alluvial valley floors" in relation to the proposed Strip Mining Control and Reclamation Act of that year:

> Alluvial valley floors refers to those unconsolidated deposits formed by streams (including their meanders) where the ground water level is so near the surface that it directly supports extensive vegetation or where flood stream flows can be diverted for flood irrigation. H.R. 9725 defines alluvial valley floors as, "the unconsolidated stream laid deposits holding streams where water availability is sufficient for subirrigation or flood irrigation agricultural activities". (Sec. 701 (27)). In more technical terms, alluvial valley floors are the upper, near-horizontal surface of the unconsolidated stream-laid deposits which border perennial, intermittent, or ephemeral streams. The alluvium that makes up the stream-laid deposits is composed of clay, silt, sand, gravel, or similar detrital material that has been, or is being, transported and deposited by streams. Alluvial valleys within this definition are traversed by perennial or intermittent streams or by ephemeral stream channels; are irrigated in most years by diversion of natural flow or ephemeral flood flow on the modern flood plain and adjacent low terraces or by subirrigation of the flood plain by underflow; and are used for the production of hay and other crops that are an integral part of an agricultural operation. Excluded from the definition are the colluvial and other surficial deposits that normally occur along the valley margins, are higher than the modern flood plain and low terraces, are not irrigated by diversion of natural flow or by ephemeral flood flow, and are not subirrigated by underflow. It should also be noted that alluvial valley floors must be an integral part of a drainage network that transverses the area under consideration. These are part of through flowing stream (hydrologic) systems and are not small areas of isolated internal drainage. (House Committee on Interior and Insular Affairs, 1976.)

Thus, the important aspects of alluvial valley floors include (1) the ability of a stream system, or its related ground water system, to provide enough water to sustain vegetative growth through the dry periods of the year, and (2) the ability of low stream terraces to be either subirrigated by near-surface ground water flow or flood irrigated by natural stream flood flows (including simple diversion of stream flows).

The specification of definitive characteristics of alluvial valley floors has been important, since geologic deposits of alluvial origin overlie much, if not all, of the coal resource areas of the Northern Great Plains. Unconsolidated alluvial deposits exist on some interstream divides and along the margins of many existing valleys in eastern Montana. It is clear from the House Committee Report language, however, that alluvial valley floors are the floodplain and low terrace areas of certain existing stream valleys and are not necessarily all alluvial deposits found in any topographic locality.

Malde and Boyles (1975) published maps of alluvial valley floors and strippable coal reserves for forty-two quadrangles in the Powder River Basin, Montana. Mapped as alluvial valley floors were the stream channel, floodplain, and low alluvial terraces that might be subirrigated or irrigated by diversion of flood waters. Generally, these terraces were not higher than 1.5 m* above the channel floor of small streams nor higher than 2.4 m above the channel floor of principal streams. Terrace areas narrower than 7.6 m were not mapped. Vegetation of these areas was identified as being principally grass mixed with silver sagebrush (Artemesia cana) along small streams and headwater areas. In a letter to then Representative John Melcher (Montana), U.S. Geological Survey Acting Director M.R. Klepper stated, in 1976, that the USGS believed that Malde and Boyle's mapping criteria were consistent with the 1976 House Committee Report and that the published maps were indicative of the relationship of alluvial valley floors to strippable coal reserves in other portions of the Powder River Basin (Klepper, 1976).

Malde and Boyles found that of the 158,637 ha** of surface within the study area underlain by strippable coal, only 4,247 ha were also alluvial valley floors. This amounts to 2.67 percent of the land surface overlying surface-minable coal resources (House Committee on Interior and Insular Affairs, 1976). Strippable coal data was taken from Matson and Blumer (1973) and includes deposits under less than 46-76 m of overburden, depending on the thickness of the underlying coal.

In 1976, the Office of Energy Activities, Environmental Protection Agency, Denver, reported that 10,878 ha of the 370,370 ha presently leased for coal mining in eight western states meets the alluvial valley floor criteria of proposed 1976 Federal legislation. This amounts to 3 percent of the area of the leased land. EPA utilized air photos for its analysis and followed Malde's mapping criteria. Generally, EPA excluded valleys narrower than 15 meters in width (Environmental Protection Agency, 1976).

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* 1 meter = 3.28 feet

** 1 hectare = .003861 square miles

No other published work exists that addresses, specifically, the relation of coal strip mining to valley floor areas. There are numerous ongoing studies related to determining the feasibility of mining and the associated environmental impacts that encompass alluvial valley floors in Montana and Wyoming; however, seldom have the investigations provided sufficient data to describe key characteristics and roles of alluvial valley floors.

Table 1

Study Areas and Locations

Area Number	Area Name	Counties	Source of Coal Data
1	Burns Creek-Thirteenmile Creek Known Coal Leasing Area	Dawson Richland	Spencer (1976)
2	Weldon-Timber Creek Deposit	McCone	Matson (1970)
3	Redwater River Deposit	McCone Dawson	Matson (1970)
4	Eastern Garfield County	McCone Garfield	None

METHOD OF INVESTIGATION

This report includes sets of maps of four areas within Dawson, Garfield, McCone, and Richland Counties. The maps are contained in the Appendix of this report (Pg.A-1 et seq.). Figure 2 shows the four-county area and the four areas of specific study. It provides an index to the topographic maps, orthophoto quadrangle maps and to aerial photo maps contained in the Appendix. Mapping of alluvial valley floors was also completed, but not included in this report, for all of Dawson County northwest of the Yellowstone River, and most of McCone County, outside the areas of specific study. The four areas of specific study are Area 1, the Burns Creek-Thirteenmile Creek Known Coal Leasing Area in Dawson and Richland Counties; Area 2, the Weldon-Timber Creek strippable coal area in McCone County; Area 3, the Redwater River strippable coal area in McCone and Dawson Counties; and Area 4, the Eastern Garfield County area in Garfield and McCone Counties.

Mapping of valley floor areas for this report was accomplished using available air photographs, supplemented by field reconnaissance performed within the constraints of time and access. Full stereo photographic coverage was available only for McCone County. USGS 7½ minute topographic quadrangle maps do not exist for any of the study areas of McCone County. The scales and sources of aerial photographs used are indicated on Table 2.

Following an initial field review, alluvial valley floors in Dawson County were mapped on air photos, then checked and revised in the field in late August. Field work in McCone and Richland Counties was conducted in September. Field work in Garfield County was conducted in early November. Air photo interpretations for these last three counties were made after field work was completed in an area. In early November vegetation was specifically evaluated in the Burns Creek-Thirteenmile Creek Known Coal Leasing Area and the Redwater River area.

Valley floors in Dawson and Richland Counties were investigated in the field at almost all sites accessible by road or trail. It is estimated that over 75 percent of the alluvial valley floor contacts in the Burns Creek-Thirteenmile Creek KCLA (Area 1) were verified in the field. Due to time and access constraints, fewer sites were mapped in the field in McCone and Garfield Counties (Areas 2, 3, and 4). It is estimated that about 50 percent of the alluvial valley floor contacts in the Redwater River area (Area 3) were mapped in the field. Alluvial valley floor mapping in the Weldon-Timber Creek (Area 2), and Eastern Garfield County (Area 4) areas is based on fewer field confirmations.

Field mapping of alluvial valley floors consisted of mapping low terrace areas and their height above the channel bottom or water level observed in standing pools. Vegetative characteristics of terraces were

Figure 2 - Study Area Showing General Location of Alluvial Valley Floors and Indicating Location of More Detailed Maps

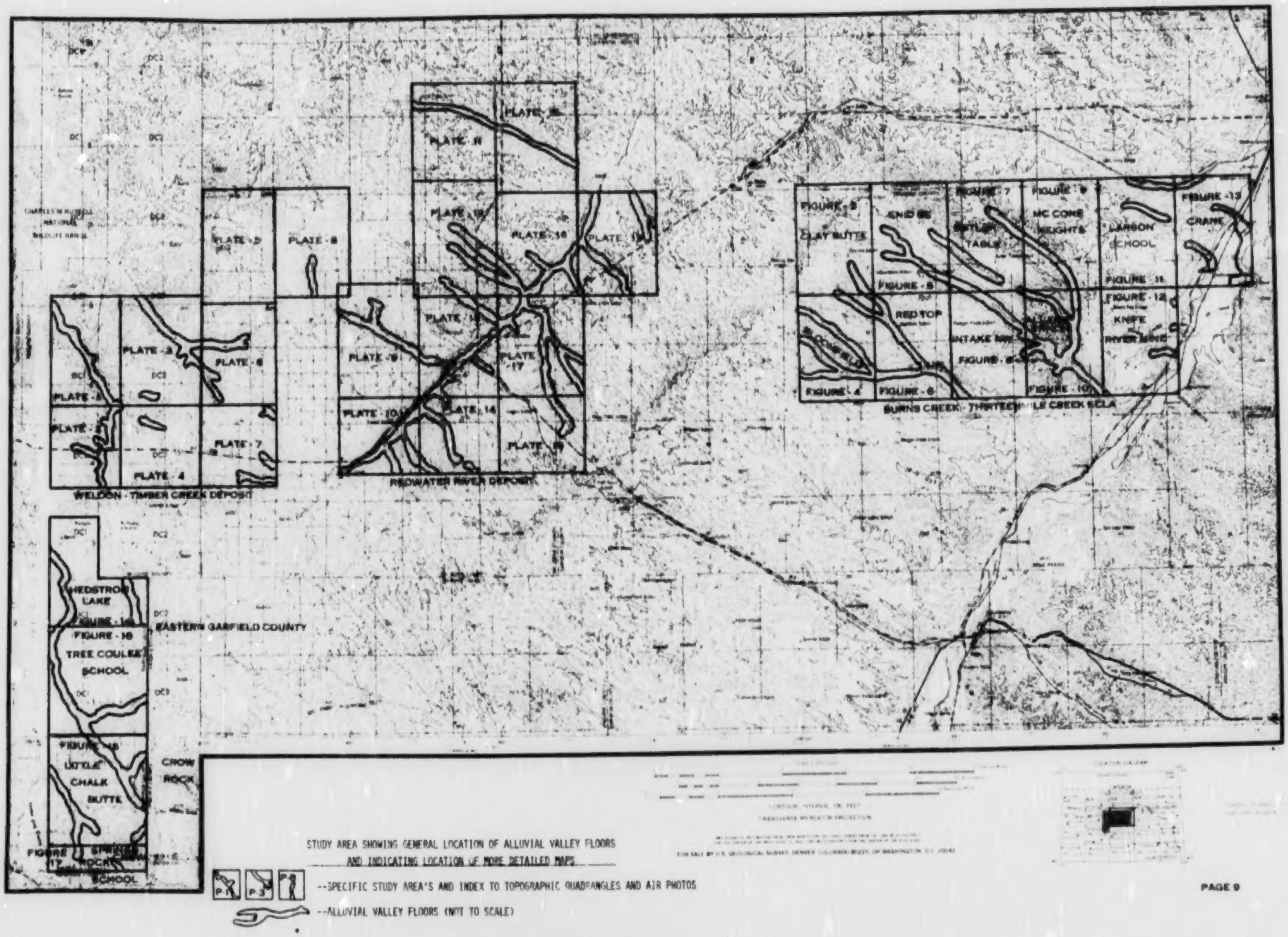
PLATE - 11
PLATE - 12
PLATE - 13
PLATE - 16
PLATE - 5
PLATE - 8
PLATE - 2
PLATE - 6
PLATE - 1
PLATE - 3
PLATE - 7
PLATE - 4
PLATE - 9
PLATE - 10
PLATE - 14
PLATE - 17
PLATE - 18
WELDON - TIMBER CREEK DEPOSIT
REDWATER RIVER DEPOSIT
FIGURE - 5
CLAY BUTTE
FIGURE - 7
BUTLER TABLE
FIGURE - 9
MC CONE HEIGHTS
LARSON SCHOOL
FIGURE - 13
CRANE
FIGURE - 11
FIGURE - 12
KNIFE RIVER MINE
RED TOP
INTAKE
FIGURE - 4
FIGURE - 6
FIGURE - 8
FIGURE - 10
BURNS CREEK - THIRTEEN MILE CREEK SCLA
HEDSTROM LAKE
FIGURE - 18
TREE COULEE SCHOOL
EASTERN GARFIELD COUNTY
LITTLE CHALK BUTTE
CROW ROCK
FIGURE 17
SPRING ROCK SCHOOL
CHARLES M. RUSSELL NATIONAL WILDLIFE RANGE
DC1
DC2
DC3
PAGE 9

STUDY AREA SHOWING GENERAL LOCATION OF ALLUVIAL VALLEY FLOORS AND INDICATING LOCATION OF MORE DETAILED MAPS

--SPECIFIC STUDY AREA'S AND INDEX TO TOPOGRAPHIC QUADRANGLES AND AIR PHOTOS

--ALLUVIAL VALLEY FLOORS (NOT TO SCALE)

noted. Since field work was done in late summer and fall, water levels in channels may represent water table levels in the alluvial aquifer, although perched water tables might exist. All lands flood irrigated for hay or cut for hay were mapped when observed. Apparent areas of saline seeps in valley floors and salt crusts along channels were also mapped based on field observations.

Numerous discussions were held with ranchers concerning their present and future use of valley floor areas, known water table levels, and salinity problems.

Mapping of high terraces, labeled "related alluvial deposits", was based principally on air photo interpretation. Due to the incomplete availability of stero air photo coverage, the accuracy of mapped contacts is only fair, perhaps ± 50 meters, with least accuracy occurring in areas of low relief. The mapping does, however, provide an indication of the extent of these deposits.

Strippable coal data was obtained from Matson (1970), Spencer (1976), and the USGS (1976). The assessment of the strippable coal tonnage underlying alluvial valley floors and related alluvial deposits was completed by measuring the area of valley floors overlying coal on maps and air photos using a polar planimeter. Coal seam thickness was estimated using published reports. The tonnage of coal was calculated by multiplying the volume of coal (area thickness of coal) by 12,787 metric tons, the weight of a hectare-meter* of lignite used by Matson (1970) and Spencer (1976). The assessment of coal tonnage underlying valley floors in the Weldon-Timber Creek as well as the Redwater Areas of McCone County is less accurate than in the Burns Creek-Thirteenmile Creek KCLA in Dawson and Richland Counties since mapping was done on uncorrected air photos. No coal resource data were available for the eastern part of Garfield County. All coal in the specific study areas is of lignite grade.

---

* the weight of a layer of coal covering one hectare in area and one meter thick.

Table 2

Sources of Air Photos Used For Mapping

County	Source	Scale	Date
Dawson	Dawson County Land Office	1:15840	1958
Richland	SCS	1:27000	1975
McCone	ASCS	1:40000	1970
	USGS	1:76000	1974
Garfield	ASCS	1:20000	1968

MAPPING UNIT DEFINITIONS AND APPLICATION

It is important to note that this effort developed a somewhat more comprehensive identification of the geologic (and gemorphologic) system related to alluvial valley floors than had been previously demonstrated. In addition to the identification of alluvial valley floors, "related alluvial deposits" were mapped. These related alluvial deposits are a geologic mapping unit that generally surrounds the alluvial valley floor (a.v.f.) and is related, hydrologically, to the alluvial valley floor by virtue of at least its appearance of being in hydrologic continuity with the alluvial valley floor. Often the related alluvial deposits include wildlife areas and marsh areas in addition to the agriculturally important alluvial valley floors. This section describes criteria used to identify "alluvial valley floors" and "related alluvial deposits." These were used to designate areas that often were found within alluvial valley floors. Similarly, "gravel bed areas," "wildlife areas," and "marsh areas" are described.

Alluvial Valley Floors were mapped as the low terrace, floodplain, and channel of major drainages and those minor drainages whose low terraces were either used in part for hay production or which appeared to have the potential for such use. These areas, where not over-grazed, support hay production or natural vegetation dependent upon greater moisture than that supplied by annual precipitation. The source of this additional moisture is assumed to be either ground water at levels accessible to vegetation, or seasonal flood flows. Mapped low terraces vary in height above the present channel, generally in relation to size of the stream, with higher terraces above larger streams.

The mapped alluvial valley floor of the Yellowstone River is about three to four meters above the present river and conforms to the "younger and lower floodplain terrace gravel" mapped in the Girard coal field (Prichard and Landis, 1975). These Yellowstone River terraces are extensively farmed for sugar beets and corn, and gravel does not impede farming. These deposits differ from the gravel deposits of smaller valleys discussed under the heading "gravel bed areas" in that they are not poorly sorted and relatively thick deposits of gravel upon which hay does not grow in great quantity. Mapped terraces along the Redwater River and Little Dry Creek are within 2.4 to 3 m of the observed water level in standing pools in the channel (Transects M-M', N-N', O-O'). Mapped terraces of smaller streams are within 2.4 m or less of the channel bottom or observed water level, and are usually within about one to 1.5 m of the channel bottom in the narrowest mapped valley floors. On several incised streams, the lowest terraces exhibiting vigorous vegetative growth are narrow and sinuous. Correlation with mapped hay lands allows evaluation of the present land use of these mapped valley floors. Deeply incised valleys, terraces without vigorous vegetative growth and valleys with extensive surfaces covered by gravel were not mapped as alluvial valley floors.

The criteria used for mapping alluvial valley floors in this report are believed to be consistent with previous work and with the intent of proposed 1976 Federal legislation. A field review with Malde was conducted in July, 1976, to help ensure consistency with similar mapping in the Powder River Basin. The inclusion of terraces somewhat higher than in other work is justified both because these terraces exhibit characteristic valley bottom vegetation and because some local ranchers raise hay on these terraces. The inclusion may be expected since the areas herein described are in a different physiographic region than those of previous studies. In cases where multiple terraces exist, however, only the lower terraces have been mapped within the alluvial valley floor. Thus, not all terraces used for hay production are included within the alluvial valley floor unit; many hayfields are found in areas mapped in the more extensive "related alluvial deposits."

Related Alluvial Deposits are the high terrace areas of streams whose lowest terraces are mapped as alluvial valley floors. They have been mapped in the Burns Creek-Thirteenmile Creek KCLA, along the Redwater River, and in Garfield County, These deposits also include some colluvial areas probably underlain by alluvium. Related alluvial deposits are mappable between discontinuous alluvial valley floors but are identified on the maps or this report for only short distances upstream from the alluvial valley floors. These related alluvial deposits could be mapped to the headwaters of each tributary.

The purpose of mapping related alluvial deposits is to show the extent of the entire valley fill area. This wider area is often the site of some type of agricultural activity and a source of recharge for ground water. In most cases, the alluvial ground water system was estimated to be integrated throughout the valley fill deposit. Thus, any prohibition of mining in areas where such activity might detrimentally affect the alluvial ground water system might likely include prohibition of mining elsewhere in the valley fill. The mapping of these areas permits an assessment of the coal tonnage underlying them.

Saline soil and saline outbreaks are either those areas where an indication of saline water or soil was observed on the land surface, such as a salt crust or saline seep, or areas mapped as saline soil in the Dawson or McCone soil surveys. Saline land was mapped as a discrete soil type in the Dawson survey. The Dawson soil description reads:

> Saline land consists of nearly level areas of poorly drained, stratified, loamy soil material that contains such large quantities of soluble salts and alkali that only the most salt-tolerant native plants can grow. Most areas have crusts of white salt on the surface and many seams of salt. Most areas have a water table at or within a few inches of the surface during most of the growing season in most years. (Holder and Pescador, 1976).

Available data on saline soils in McCone County were obtained from the survey in progress (Don Strom, Project Leader, McCone County Soil Survey, personal communication). The saline soils mapped in this effort are equivalent either to "typic fluvaquents on 0-2 percent slopes and saline", or to the Alona series used in the soil survey. Typic fluvaquents are generally silt loam soils on floodplains of streams of the unglaciated portion of the county. These saline soils tend to have surface and subsurface gypsum crystals. The Alona soils are well-drained silt loams formed in calcareous alluvium with a moderately alkaline surface layer. The subsoil of the Alona soils is moderately to strongly alkaline, and the underlying material is strongly alkaline (Strom, in progress). These saline soil areas were mapped to show one of the potential limitations to agricultural use of valley bottom lands. Saline channels indicate potentially unacceptable water quality for irrigation, and saline terraces indicate areas where cropping might prove unsuccessful.

Inspection of the maps and air photos shows, nonetheless, that saline bottom lands are cropped for hay in several places. Often alfalfa is used to control salt or alkali build-up. In other cases, saline bottom lands produce acceptable crops of natural hay.

Hayed lands include all valley bottom and nearby lands where hay, either natural or alfalfa, was observed to be harvested, and lands observed to be irrigated for that purpose. Also included are irrigated lands observed on air photos and lands mapped as such by the Montana Water Resources Board in its various Water Resources Surveys. (MWRB, 1970, 1971a, 1971b, 1971c). These surveys represent complete evaluations of irrigated lands up to the publishing date for each survey. Also included are lands presently taxed as "wild hay lands" in Dawson and McCone Counties under the Montana Agricultural Land Classification. Irrigated lands in the Yellowstone River valley are not mapped since hay is not an important crop in that area.

Gravel bed areas represent those valley bottom areas where gravel is so abundant as to limit any land use except grazing. These areas occur only in the Burns Creek-Thirteenmile Creek area where streams such as Dunlap and Crane Creeks, cut through the Flaxville and Cartwright Gravels. Most mapped gravel areas were observed in the field.

Wildlife areas are those valley bottom lands in headwater areas, generally wider than 7.0 m bounded by high bluffs and dense tree and brush growth; areas that were not mapped as alluvial valley floors. They represent important sources of browse and cover for mammals and game birds. These areas are generally found in "breaks"* areas and are usually not used for farming. These areas are also important for shelter and browse for livestock.

Marsh areas are those areas too wet for any agricultural use or are local low-lying, subirrigated areas not integrally related to the drainage system. They often provide excellent waterfowl habitat.

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* A relatively abrupt change in topography such as at the edge of terraces or at the head of a river. The land surface is relatively rough or broken.

COAL DATA

Strippable coal data are incomplete for the general study area. The specific study sites, designated Areas 1, 2, and 3, in McCone and Dawson Counties represent the only mapped strippable coal data for the entire study area. The interpretations of High, Moderate, and Low Potential Coal Development Areas within the Burns Creek-Thirteenmile Creek KCLA (USGS, 1976) are based on the work of Spencer (1976). These categories of potential coal development are based generally on overburden thickness modified by the thickness of the underlying coal. The coal potential development analysis of Spencer has been conducted to assist the Bureau of Land Management in developing management policies for mineral development. The Potential Coal Development maps are not intended as a regular publication of the USGS but are chiefly used as an internal government planning tool.

The work of Matson (1970) in McCone County provides an evaluation of coal reserves generally comparable to the USGS analysis in High Potential Development Areas. Matson's data were used to determine strippable coal areas in the Weldon-Timber Creek and Redwater River strippable coal areas. Matson mapped coal deposits under less than 45.8 m of overburden, generally the same criteria as for High Potential Development. No strippable coal data have been published for Garfield County and thus the coal resource has not been evaluated in Area 4.

In an attempt to indicate other areas outside of those presently mapped as strippable, Bureau of Land Management sections nominated by industry for coal leasing have been mapped in McCone and Garfield Counties (Bureau of Land Management, 1976). No data are offered as to how much coal exists or at what depth is occurs in these sections. They are mapped only to indicate industry interest in localities. Since Bureau of Land Management control of minerals is geographically limited to certain land sections, a checkerboard pattern of nominated sections is evident. Intervening private and state sections are likely to have coal deposits of commercial interest where surrounding Bureau of Land Management sections have been nominated.

PHYSIOGRAPHIC DESCRIPTION OF STUDY AREAS

All four study areas are characterized by rolling hills and open valleys (Figure 2). Most flat and gently sloping lands are dryland farmed for winter wheat in Dawson, Richland, and McCone Counties. Extensive ground breaking is currently taking place in Garfield County. Topographic relief is low in the area; total relief in the Burns Creek-Thirteenmile Creek KCLA is about 366 m, and in all of McCone County, maximum relief is only 396 m (Collier and Knechtel, 1939). The only perennial stream in the four study areas is the Yellowstone River. The other two principal streams, the Redwater River and Little Dry Creek, cease flowing in late summer but hold water in large pools irregularly scattered along the channel course. Some smaller streams also hold water in standing pools after flow ceases; others dry up completely.

The entire area receives only limited rainfall. Annual precipitation averages between 30 and 36 cm* in each study area. For the period January to November, 1976, Circle, in McCone County, received 3.7 cm of precipitation below its normal of 31.7 cm, and Glendive, in Dawson County, received 1.1 cm below its normal of 35.1 cm (U.S. Department of Commerce, 1976).

All areas are underlain by flat lying or gently dipping beds of the Tongue River Member of the Fort Union Formation. Gravel deposits of Pleistocene and pre-Pleistocene erosion surfaces cover much of the flat table lands of the Burns Creek-Thirteenmile Creek KCLA. The study areas were moderately affected by Pleistocene glaciations. Ice did at one time cover the eastern third of the Burns Creek-Thirteenmile Creek KCLA and the northern fringe of the Redwater River study area. The Redwater River valley, and its tributaries were inundated by glacial Lake Circle during this time, as ice blocked the northward flowing stream. Glacial Lake Jordan covered the southwestern part of the Weldon-Timber Creek area and much of the eastern Garfield County area (Colton, et.al., 1961). Glacial Lake Lambert, near the present town of Lambert, Montana drained down the present North Fork of Burns Creek, cutting an impressive valley which is wider and flatter than other streams of comparable size in the area (Howard, 1960). Except for the North Fork of Burns Creek and small valleys farther east, however, the situation of underfit streams is non-existent and the terrace sequence found along the streams of each of the areas has developed since retreat of the ice (i.e., post-glacial).

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* 1 cm = 0.39 inches

ESTIMATES OF AREA INVOLVED AND COAL RESOURCE UNDERLYING ALLUVIAL VALLEY FLOORS

The results of this study are presented in several topographic maps, photo-maps, tables, and cross sections provided in the Appendix. Figure 2 shows the four study areas and the mapped alluvial valley floors of each area. This figure also serves as an index for topographic quadrangles and aerial photos of a more detailed nature. Topographic 7½-minute quadrangle maps (Figures 3-13) show alluvial valley floors, related alluvial deposits, and strippable coal in the Burns Creek-Thriteenmile Creek KCLA (Area 1). Also included are othophoto quadrangles (Plates 20-30) of the same area showing characteristics of the alluvial valley floors. Plates 1-19 are mapped air photos showing coal resources, alluvial valley floors, and valley floor characteristics in the Weldon-Timber Creek (Area 2) and Redwater River strippable coal areas (Area 3). Also included are maps of alluvial valley floors, related alluvial deposits, and nominated coal lease tracts in eastern Garfield County (Figures 14-17). Transects showing the topography and vegetation at selected points across the alluvial valley floors are provided in the Appendix (Figures 18-33).

The amounts of coal underlying valley floors have been estimated for the Burns Creek-Thirteenmile Creek KCLA and the Weldon-Timber Creek and Redwater River strippable coal areas. Since no strippable coal data or thickness-of-coal data have been published for eastern Garfield County, no tonnage estimates were made. Maps of this area are included to permit visual evaluation of the relation of alluvial valley floors to lands of potentially strippable coal (industry nominated BLM lands) and to permit evaluation of the characteristics of those alluvial valley floors.

The evaluation of coal tonnage underlying valley floors shows that:

1. A small percentage of the total reserves of the high potential strippable coal deposits of the Burns Creek-Thirteenmile Creek KCLA (Area 1) and the Weldon-Timber Creek (Area 2) strippable coal area underlie alluvial valley floors (1.5 and 2.4%, respectively).

2. A small (2.8%) percentage of the reserves in Area 1 underlie the entire valley fill (mapped as related alluvial deposits) of the valleys containing alluvial valley floors.

3. Eight percent of the tonnage of the Redwater River strippable coal deposit (Area 3) underlies alluvial valley floors and about sixteen percent underlies the entire valley fill area of the valleys containing alluvial valley floors.

4. Examination of the mapped air photos for the Redwater River deposit (Area 3) shows that in some areas, the organization of mining units might be constrained by the prohibition of mining in the alluvial valley floor and related alluvial deposits. As such, the affected reserves might be much greater than the percent of the tonnage if mining were prohibited in the entire valley fill.

   The development of coal strip mines depends on the ability of a company to economically recover the coal reserves of an area. It is important for a company to balance areas of thick and thin overburden so that steady production levels are maintained. Thus, the prohibition of mining in the valley floor of the Redwater River, where overburden thickness is least, might limit the ability of a company to mine other areas of greater overburden.

   It appears that despite the potential for alluvial valley floors to affect the creation of logical mining units in the Redwater River deposit area, substantial strippable coal reserves remain available in the area.

5. A similar situation to that cited in (4) does not appear to be the case in either the Burns Creek-Thirteenmile Creek KCLA or the Weldon-Timber Creek strippable coal deposit (Areas 1 and 2). In other words, in Areas 1 and 2, the constraints on mining that would be imposed if operations had to avoid alluvial valley floors would probably not be great.

Area 1 Burns Creek - Thirteenmile Creek KCLA

The results of field mapping in Area 1 are contained in a combination of topographic quadrangle maps (Figures 3 through 13), orthophoto quadrangles (Plates 20 through 30) and transects drawn in cross-section (Figures 18 through 29). All are contained in the Appendix. The topographic maps provide coal resource data and show the location of alluvial valley floors and the surrounding related alluvial deposits. The orthophoto quadrangles show the identical alluvial valley floors, plus upstream wildlife areas. These wildlife areas are mapped as extending well up into the headwaters of the major drainages (See Clay Butte Orthophoto: Plate 20). Hayed lands and saline areas are also mapped in the orthophoto quadrangles (e.g., Butler Table Orthophoto: Plate 24). Note that in some instances the hayed lands are completely within the alluvial valley floors (Plate 25 Intake NW) while in other areas the hayed lands extend into highland areas (Plate 20 Clay Butte).

The locations of transects are shown on the orthophoto quadrangles. The transects provide more detailed analyses of the topography and vegetation found at selected locations in Area 1. Specific vegetative communities are described and located along with designations of alluvial valley floors and wildlife areas where encountered.

Of the 2.64 billion metric tons* of coal lying under less than 45.8m of overburden (High Potential Development Areas) in the Burns Creek-Thirteenmile Creek KCLA (Spencer, 1976), 39.18 million metric tons underlie alluvial valley floors mapped and 72.20 million metric tons underlie the related alluvial deposits mapped of these same valleys. These constitute 1.5 percent and 2.8 percent, respectively, of the high potential development coal reserves. Table 3 summarizes the affected reserves in each quadrangle for these levels of potential development. No alluvial valley floors were identified in areas investigated north of Clay Butte, Enid SE, and Butler Valley, (Figures 3, 5, 7), within the KCLA boundary. Coal reserve data from Spencer (1976) for these quadrangles is included in the data for total KCLA reserves.

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* 1 metric ton = 1.10 short tons

Table 3
Tons of Coal Underlying Alluvial Valley Floors (AVF) And All Related Alluvial Deposits (AD)

Burns Creek-Thirteenmile Creek KCLA

USGS 7.5-minute Quadrangle Map	High Potential Development Area a) (Million Metric Tons)		Moderate Potential Development Area a) (Million Metric Tons)		Low Potential Development Area a) (Million Metric Tons)		Total	
	AVF	AD c)	AVF	AD c)	AVF	AD c)	AVF	AD c)
Allard Ranch (Figure 10)	4.7	9.1					4.7	9.1
Bloomfield (Figure 4)	0.5	0.5					0.5	0.5
Butler Table (Figure 7)	13.7	30.4	1.8	1.8	9.9	12.1	25.4	44.3
Clay Butte (Figure 3)	1.3	2.4					1.3	2.4
Crane (Figure 13)	0.4	1.8					0.4	1.8
Enid SE (Figure 5)	3.5	5.6	11.8	13.5	8.5	8.8	23.9	27.9
Intake NW (Figure 8)	12.2	17.1					12.2	17.1
Larson School (Figure 11)				0.3				0.3
McCone Heights (Figure 9)		0.4						0.4
	36.4	67.0	13.6	15.6	18.4	20.9	68.4	103.9
Estimated Total Reserves in KCLA (Spencer, 1976)	2400		1600		2400		6400	
Percent of Reserves Under Alluvial Valley Floors and Alluvial Deposits	1.5%	2.8%	0.8%	1.0%	0.8%	0.9%	1.1%	1.6%

a) Potential for mining of coal determined by Spencer (1976). "High Potential" for extraction exists with shallow overburden and thick coal. Coal data are based on the Pust Seam.

b) 1 metric ton = 1.10 short tons

c) Related alluvial deposits include alluvial valley floors.

Table 4 shows that only 536 ha of alluvial valley floors were mapped within the KCLA, and that the entire mapped alluvial deposts amounted to 1,168 ha. The total area of alluvial valley floors outside the KCLA was not determined.

Table 4

Area of Alluvial Valley Floors (AVF) and All Related Alluvial Deposits (AD) Overlying Coal Reserves

Burns Creek-Thirteenmile Creek KCLA

Quadrangle Map	High Potential Development Area[a] (hectares)[b]		Moderate Potential Development Area[a] (hectares)[b]		Low Potential Development Area[a] (hectares)[b]		Total	
	AVF	AD[c]	AVF	AD[c]	AVF	AD[c]	AVF	AD[c]
Allard Ranch	31.08	59.57					31.08	59.57
Bloomfield	5.18	5.18					5.18	5.18
Butler Table	98.42	391.1	12.95	12.95	69.93	85.47	181.30	489.51
Clay Butte	36.26	80.29					36.26	80.29
Enid SE	25.9	41.44	88.06	101.01	77.70	98.42	191.66	385.91
Intake NW	90.65	132.10					93.24	132.03
Larson School				10.36				10.36
McCone Heights		7.70						7.70
							536.13	1168.09

a) Potential for mining of coal determined by Spencer (1976). "High Potential" for extraction exists with shallow overburden and thick coal. Coal data are based on the Pust Seam.

b) 1 hectare = .003861 square miles.

c) Related alluvial deposits include alluvial valley floors.

Area 2 Weldon-Timber Creek Deposit

The results of field mapping in Area 2 are contained on aerial photographs (Plates 1 through 8) contained in the Appendix. These plates illustrate the alluvial valley floors. The areas of strippable coal mapped by Matson (1970) are shown along with legal descriptions of lands nominated for future competitive coal leasing as part of the EMARS process of the Department of Interior's land planning system. Hayed lands and areas of saline soils were also mapped. Wildlife areas extending upstream from the alluvial valley floors may be seen in the Skull Creek (Plate 4) and other areas.

Noteworthy is the fact that saline-tending soils exist along many of the alluvial valley floors. However, it is not uncommon to have hayed lands on the saline soils of the alluvial valley floors (e.g., Nelson Creek - West Aerial Photograph, Plate 3). Plates 6 and 7 show examples of some entrenched streams that provide refuge for wildlife.

Table 5 shows that 2.4 percent of the tonnage of the Weldon-Timber Creek deposit underlies alluvial valley floors. Only 17.4 million metric tons of the 722 million metric tons of the entire deposit are under alluvial valley floors. The "related" alluvial deposits were not mapped for this area. The areal extent of the high terraces in the valleys of this study area is not great. It is not felt that substantially greater reserves underlie the related alluvial deposits than lie adjacent to the alluvial valley floors.

Table 5

Area of Deposits and Coal Tonnage Underlying Alluvial Valley Floors

Weldon-Timber Creek Deposit[a)]

Mapped Air Photo	Area (hectares) AVF	Tons (million metric) AVF
14	25.90	1.8
16	126.91	8.3
17	88.88	2.6
19	95.83	3.1
	331.52	15.9

Estimated Reserves in KCLA (Matson, 1970)	657 million metric tons
Percent of Coal Reserves (Tonnage) Under Alluvial Valley Floors	2.4 percent

a) Coal Data for "s" Bed (Matson, 1970)

Area 3 - Redwater River Deposit

In the Redwater River deposit, 8 percent of the coal reserve tonnage underlies alluvial valley floors, and 15.6 percent underlies alluvial valley floors and the related alluvial deposits (Table 6). If alluvial valley floors and related deposits were excluded from mining, other areas bordering the valley fill of the deposit might become uneconomical to mine because of problems in developing a logical mining unit. As such, the estimate of affected reserves might be substantially increased. There are about 532.40 ha of alluvial valley floors overlying the deposit and about 1,787 ha including related alluvial deposits. Although much of the coal resource underlies the Redwater River and Horse Creek in the vicinity of Circle and lies under or near alluvial valley floors, other reserves are found away from the river valley, expecially in the area between Buffalo Creek and Duck Creek (see Plate 16). This "upper" coal reserve is almost totally unaffected by alluvial valley floors. The strippable reserves are known to extend into Dawson County (Matson, 1970), and these reserves would be overlain by the alluvial valley floors of Sullivan and Pasture Creeks (unpublished mapping by author).

The results of field mapping conducted in Area 3 are represented on aerial photographs (Plates 9 through 19) and transects (Figures 30 through 33). The aerial photographs show alluvial valley floors and the location of strippable coal deposits as mapped by Matson (1970). Hayed lands, lands nominated for future coal leasing, and areas of saline soils are shown on Area 3 photographs as they were for Area 2 (Plates 1 through 8). Wildlife areas are not mapped, but would be expected to extend upstream from such tributaries as the North and South Forks of Buffalo Creek (Plate 12), McCone Creek and Hell Creek (Plate 14). It would appear that much of the hayed lands are located in areas resembling the related alluvial deposits although they were not mapped. (See, for example, Plate 13.)

Transect locations for Area 3 are shown on the aerial photographs. A characteristic transition from a blue gramma to a reedgrass-dominated association as one progresses toward the alluvial valley floor is evident in Figures 30 and 31. In Figures 32 and 33, the reedgrass is replaced by a saltgrass-dominated association in much of the alluvial valley floor.

Table 6
Area of Deposits and Coal Tonnage Underlying Alluvial Valley Floors (AVF) and All Related Alluvial Deposits (AD)[a]

Redwater River Deposit

Mapped Air Photo Number	Area (hectares)[b]		Tons (million metric)[c]	
	AVF	AD[d]	AVF	AD[d]
1	98.42	98.42	0.4	0.4
3	170.49	310.80	6.3	11.3
4	230.51	603.47	9.0	23.6
8	414.40	753.69	29.6	59.1
10	15.54	15.54	1.2	1.2
	929.81	1,781.92	46.4	90.6

Estimated Reserves in Redwater River Deposit (Matson, 1970)	582 million metric tons
Percent of Coal Reserves (Tonnage)	
Under Alluvial Valley Floors	8.0 percent
And Alluvial Deposits	15.6 percent

a) Coal Data for "s" Bed (Matson, 1970)

b) 1 hectare = .003861 square miles

c) 1 metric ton = 1.10 short tons

d) Related alluvial deposits include alluvial valley floors

Area 4 - Eastern Garfield County

Area 4 was examined in a somewhat limited fashion due to the absence of published coal resource data. As noted earlier, the area was investigated because of the high degree of interest indicated by nominators of potential coal lease tracts during the recent call for nominations issued by the Department of the Interior under the EMARS.

The results of field investigations of the location of alluvial valley floors are presented in topographic quadrangle maps (Figures 14 through 17) in the Appendix. Shown on these maps are the alluvial valley floors, related alluvial deposits, the sections of land nominated for leasing, and lands that were in hay production during the field season of 1976. Also shown are those areas of saline crusts and/or apparent saline seeps where such were found along the drainage channels.

There appears a moderate degree of positive correlation between the areas mapped as related alluvial deposits, which include alluvial valley floors, and the hayed lands. Potential overlap of alluvial valley floors and surface mineable coal reserves appear to be located principally along Timber Creek (Figures 14 and 15).

VALLEY FLOOR CHARACTERISTICS

Several characteristics of valley floor areas were identified and mapped. These included vegetation, salinity, gravel areas, hayed lands, and property value assessment (See plates and figures in Appendix).

The evaluation of valley floor characteristics shows that:

(1) Valley floor areas have different vegetative communities than upland areas, and that these valley floor areas are more productive for forage use.

(2) Valley floor productivity in Dawson County is reflected in higher land value assessments for these areas, however, this is not the case in McCone County.

(3) The poor condition of most valley floor areas of western McCone and eastern Garfield County may be a function of grazing pressure, based on discussions with the SCS. Thus, the potential forage productivity of these areas is probably much greater than is found today.

(4) Soil salinity is a significant characteristic of many valley floors of McCone and Garfield County. It is generally considered a limitation to agricultural use in SCS soil surveys and irrigation capability surveys by the Montana Water Resources Board. However, local farms and ranchers have developed many saline areas for hay production.

(5) Although exact percentage figures were not determined, hayed and irrigated lands in each study area probably comprise no more than twenty-five percent of the mapped valley floors.

(6) The relationship of silver sagebrush to low terrace areas observed in the Powder River Basin (Malde and Boyles, 1976) is not clear within the study area. Dense stands of silver sagebrush were observed on terraces four meters above the bottom of the dry channel of Prairie Elk Creek in McCone County; three meters above the channel of the Redwater River; in many flat-floored valleys in "breaks" country where no channel is observed to cut the valley floor, and on many alluvial fans in Dawson County. Although silver sagebrush is often found in valley floor areas, it is not identified as part of the climax vegetation community of either the overflow or saline lowland rangesites. Its abundance on valley floor terraces in the study area may be a function of past grazing pressure.

(7) Important areas of wildlife habitat and livestock shelter (mapped as Wildlife Habitat) exist in the headwaters of many streams, upstream of the agriculturally-important alluvial valley floors. These areas provide an important contrast in habitat to the general flat-lying and open character of most of the area. Although the agricultural potential of these areas is low, they are an important aspect of the wildlife habit.

The main finding is that valley floors in these study areas are most important as forage producers and secondarily as sites of hay production.

Vegetation

Valley floor vegetation is illustrated in the series of transects prepared for the Burns Creek-Thirteenmile Creek KCLA and for the Redwater River area, and the preliminary plant coverage summary data for saline lowland sites in the Weldon-Timber Creek area. Richard Pokorny* identified species composition for the transects and Richard Prodgers (unpublished) compiled the results of his first field season's work at the proposed Burlington Northern mine site (within the Weldon-Timber Creek area) for the saline lowland sites. Comparisons with productivity of lowland and upland range sites were made using general data available from the Soil Conservation Service and discussions with Gene Handle, Range Conservationist, SCS, Miles City.

Typically, species diversity and productivity on lower terraces increases as available moisture increases. Species such as blue grama (*Bouteloua gracilis*) and western wheatgrass (*Agropyron smithii*) which are common on upland range sites decrease as a percentage of the total plant cover with increasing moisture, and there is an increase in species such as switch panicgrass (*Panicum virgatum*), kentucky bluegrass (*Poa pretensis*), canada wildrye (*Elymus canadensis*), prairie sand reedgrass (*Calamovilfa longfolia*), dropseed (*Sporobolus* spp.) and slender wheatgrass (*Agropyron trachycaulum*). Shrubs and trees correlated with moister conditions include woods rose (*Rose woodsii*), common snowberry (*Symphoricarpos albus*), canadian buffaloberry (*Shepherdia canadensis*), and plains cottonwoods, (*Populus deltoides*). Horsetail (*Equisetum* spp.) is also found in some of these areas.

Detailed field investigations were made across drainage channels at selected locations. The results of these investigations are shown on transects contained in the Appendix (Figures 18-33). Characteristically, the larger valley floors of the Burns Creek-Thirteenmile Creek KCLA are predominantly grass covered with isolated cottonwood and shrub growth on lower terraces (Figures 18,20,21). Some stream transects have thick stands of cottonwoods (Figure 19). Upstream transects in wheat farming areas show narrower valley floors that are sometimes incised by channels two meters deep. Alluvial valley floor vegetation usually reflects moist conditions (Figures 23-26). In "breaks" country, or simply where the upstream valley has cut a deep flat-floored trench, trees and brush are common (Figures 22,24). These valleys in "breaks" country have been mapped as wildlife habitat. The smaller streams of the KCLA, east of Burns Creek, have vegetation similar to the transects described (Figures 27, 29), or they are gravel bed, braided streams with little surface vegetation (Figure 28).

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*Range Specialist, Montana Reclamation Division

In many of the headwater areas of streams draining lands where wheat farming is common, vigorous vegetative growth and subirrigation is common. Often these stream channels are marshy, and they may, or may not, be connected with the integrated drainage system. The source of the waters in these channels is believed to be surface and ground water flow from nearby wheatfields.

Transects M-M', N-N', O-O' in the Redwater River valley indicate that vegetation on the widest and most continuous high terraces is more characteristic of upland areas (Figures 30, 31, and 32). These areas are predominantly covered by blue grama and western wheatgrass. Only the lower terraces have vegetation similar to vegetation in the valleys of the KCLA. The vegetation of Horse Creek (Transect P-P' in Figure 33) is typical of saline areas throughout McCone County. Percent coverage of inland saltgrass (Distichlis stricta) is very high, and trees and shrubs are very rare.

If observed water level in the stream channel reflects water level in the nearby alluvium, then low terrace vegetation herein described can be used in future field work in identifying subirrigated areas. These grass species would identify areas where ground water would be available for subirrigation of alfalfa or natural hay crops. Only observation wells can document alluvial ground water table levels.

Table 7 is a summary of plant coverage data for partially to very saline alluvial terraces near Nelson Creek in the Weldon-Timber Creek coal deposit area (Prodgers, 1976). These data confirm the significance of inland saltgrass on McCone County terraces. Other important species are blue grama, American bullrush (Scirpus americanus), western wheatgrass, needle-and-thread (Stipa comata), crested wheatgrass (Agropyron cristatum), and bluegrass (Poa spp).

The importance of alluvial valley floors for forage production can be seen in Table 8, which shows production data for the various range sites of Dawson County. Range sites are groupings of soil types whose climax vegetative cover is similar. Each range site listed in Table 8 is thus a soil association that covers a percentage of the total area of the county. The overflow range site consists only of channel and terrace soils and the saline lowland range site consists only of saline channel and terrace soils. It can be seen that forage production in overflow and saline lowland range sites, which characterize almost all the mapped alluvial valley floors, is higher than for any other range sites and that production from these range sites in less favorable years is greater than favorable year production for many of the county's other range sites.

Growing conditions for vegetation of overflow range sites (one of the kinds of areas characteristic of alluvial valley floors) vary depending on management, but the potential climax community of these areas is estimated by the SCS to be:

	% composition by weight
western wheatgrass	30%
other tall grasses	20%
green needlegrass	15%
woody plants	10%
needle-and-thread	5%
big bluestem	5%
little bluestem	5%
slender wheatgrass	5%
perennial forbs	5%

(Holder and Pescador, 1976)

The SCS makes the following observations regarding the overflow range site:

> This site is mostly in fair and good condition. In some areas good management has allowed the better grasses to maintain themselves, and the site is in excellent condition. Most of this site has been overgrazed in the past by sheep and cattle. In some small areas silver sagebrush, rosebush, and snowberry have increased and are a dominant part of the plant cover. This site generally recovers rapidly if proper grazing use and a planned grazing system are employed. Response is slow where the plant cover is dominated by Kentucky bluegrass or smooth brome. Brush control is feasible in small local areas where silver sagebrush, rosebush, or snowberry are dominant in the plant cover. Most of this site is not suited to mechanical improvement because of the erosion hazard if the plant cover is destroyed.
>
> An even balance of grazing between this site and adjacent sites is difficult to obtain because of the shade, shelter, longer green grass period, and available water on this site. Consequently, where tracts of this site are sufficiently large, grazed areas should be separated by fences to facilitate good grazing management.

(Holder and Pescador, 1976)

Table 7

Summary of plant coverage data for partially to quite saline alluvial terraces, near Nelson Creek, McCone County. Visual estimates of coverage, modified from Daubenmire (1959), were made for four by eight meter plots. Data are compiled from twenty plots.

Species	Constancy[1]	Average Coverage[2]
Inland saltgrass	85%	36.55 %
Blue grama	35%	11.65 %
American bullrush	15%	11.625%
Needle-and thread	30%	4.825%
Crested wheatgrass	10%	3.875%
Bluegrass	40%	2.625%
Triglochin maritima	10%	1.9 %
Alkaligrass	15%	.925%
Nuttall saltbush	10%	.775%
Fringed sagewort	15%	.2 %
Alkali cordgrass	10%	.175%
Tumblegrass	10%	.175%
Treadleaf sedge	10%	.175%
Kochia	25%	.125%
Plantago patagonica	25%	.125%
Rough false pennyroyal	15%	.1 %
Common dandelion	15%	.075%
White milkwort	10%	.05 %
Foxtail barley	10%	.05 %
Cheatgrass brome	10%	.05 %
Plains pricklypear	10%	.05 %
Broom snakeweed	5%	.025%
Common salsify	5%	.025%
Blue flax	5%	.025%
Yarrow	5%	.025%
Small-leaf pussytoes	5%	.025%
Common milkweed	5%	.025%
American vetch	5%	.025%
Silver sagebrush	5%	.025%
Scarlet globemallow	5%	.025%
Conyza canadenis	5%	.025%
Stiffstem flax	5%	.025%
Coryphantha vivipara	5%	.025%
Indian ricegrass	5%	.025%
TOTAL		82.685%

---

[1] $\text{Constancy} = \dfrac{\text{number of plots species found}}{\text{total number of plots (20)}}$

[2] $\text{Average coverage} = \dfrac{\text{Summation of "midpoint" coverage of species from all plots}}{\text{total number of plots where species found}}$

Cover class estimates used in field evaluation were:

	"Mid point"
T = 1%	1.0
1 = 1-5%	3.0
2 = 5-25%	15.0
3 = 25-50%	37.5
4 = 50-75%	62.5
5 = 75-95%	85.0
6 = 95-100%	97.5

Methodology: designations T through 6 were made in field. Utilizing the conversions for these cover classes (e.g., 2 = 5-25%) the midpoint of each class was substituted in the equation for average coverage.
(Prodgers, unpublished)

Table 8

Generalized Range Site Productivity Data: Dawson County

(Holder and Pescador, 1976)

range site	estimated annual yield (Kg[1] of air-dry herbage)		percent of annual yield available as forage	estimated annual yield of forage (Kg[1] of air-dry herbage)	
	favorable yr.[2]	less favorable yr.		favorable yr[2]	less favorable yr.
alluvial valley floor					
overflow	1134	680	85%	964	578
saline lowland	998	544	95%	948	517
non alluvial valley floor					
sands	916	454	90%	735	408
sandy	726	408	90%	653	367
silty	680	363	95%	646	348
clayey	590	363	95%	561	348
thin hilly	544	45	95%	517	43
shallow clay	408	181	85%	347	154
gravel	363	181	95%	345	172
shallow to gravel	363	181	95%	345	172
dense clay	363	181	90%	327	163
panspots	363	181	80%	290	145
very shallow	181	91	90%	163	82
saline upland	272	136	10%	27	14

---

[1] One Kilogram = 2.2 pounds

[2] This is SCS term; no definition available

Productivity of the saline lowland range site is also high. In Dawson County, the climax plant community of these areas is estimated to be:

alkali sacaton	45%
western wheatgrass	15%
saltgrass	10%
alkali cordgrass	10%
alkali grass	5%
slender wheatgrass	5%
bearded wheatgrass	5%
sedge	5%
squirreltail	3%

(Total exceeds 100% since certain species occur as overstory or understory.)

The SCS makes these comments on the saline lowland range site:

> Under continued heavy grazing, alkali sacaton and western wheatgrass decrease and are replaced by saltgrass, mat muhly, foxtail barley, curlycup gumweed, tumblegrass, rushes, and annual plants.
>
> The site ranges from fair to excellent in condition, depending on how severe the use of the area by livestock has been in the past. In some areas good management has allowed the better plants to maintain themselves, and the site is in excellent condition. In some areas saltgrass has increased and is the dominant plant. This site recovers rapidly when proper grazing use and a grazing system are employed if enough of the better grasses are present. These saline-alkali soils are not suited to mechanical improvement practices.
>
> (Holder and Pescador, 1976)

Range site descriptions for the other study areas are generally comparable with those of Dawson County (Gene Handle, pers. comm.). The abundance of inland saltgrass in McCone County and Garfield County is believed to be a function of sustained high grazing pressure. Rehabilitative programs could decrease the coverage of inland saltgrass (Handle, pers. comm.) in these areas.

These data for overflow and saline lowland sites (Table 8) indicate that the vegetative characteristics of valley floor areas include differences in species composition and higher forage productivity in terms of hay production than upland range areas.

Saline Areas

The extent of saline lands can be seen on the maps and air photos of the study areas. Saline soils are most significant in Garfield County, the Weldon-Timber Creek area, tributaries of the Redwater River flowing from the west, and much of the North Fork of Thirteenmile Creek. Salt-lined channels are common in McCone and Garfield County, as are saline seeps in valley floors. No studies were made of the sources of this salinity, but it is likely to be a combination of naturally occurring salts leached from bedrock, aggravated by increased ground water flow in wheat farming areas. Because wheat farming is not extensive in the Weldon-Timber Creek of Garfield areas, salinity is apparently related to natural conditions in these areas.

Although saline areas are not recommended by the SCS for irrigation or ground breaking (Holder and Pescador, 1976), many areas are presently under such use. A portion of the North Fork Thirteenmile Creek, several eastward flowing tributaries to the Redwater River, and portions of Timber and Nelson Creeks are under such use. Recent irrigation of terraces has led to saline problems along Little Dry Creek (T17N, R43E, Sec.33) in eastern Garfield County. It is difficult to assess the limitations of salinity on hay production in the saline areas, since several ranchers raise hay where salinity has been mapped. Over long periods of time, production is likely to decrease in these areas and their best use will probably be as rangeland.

Gravel Areas

Gravel bed areas in the Burns Creek-Thriteenmile Creek KCLA are locally significant where streams drain deposits of the Flaxville and Cartwright Gravels. The characteristics of such streams have been illustrated (Transect L-L'). Some gravel areas were found upstream of the alluvial valley floors mapped (see Figure 11). However, these areas are probably hydrologically related to the alluvial valley floors located downstream. The presence of scattered cottonwoods within the gravel areas indicates the availability of ground water. It is likely that the gravel areas located upstream of alluvial valley floors, and upstream of wildlife areas, serve as recharge zones for the alluvial aquifers. Thus, disruption of these areas would affect the subirrigation of downstream alluvial valley floors to some, as yet undetermined, degree.

Hayed Lands

Hayed lands include undeveloped lands cropped for hay, flood irrigated lands, and ditch irrigated lands in all valleys other than the Yellowstone. Some areas mapped in the Water Resources Surveys as hayed lands may not be cropped for hay. It is estimated that over seventy five percent of mapped alluvial valley floors are not currently in hay production.

This is probably due to several factors. Some lands are cut only once every several years for hay and might not have been observed in 1976 or recorded under the land classification. Only systematic contact with all ranchers and farmers could produce data on all lands ever cut for hay. Also, many of the alluvial valley floors are sinuous and difficult to crop.

Although data are lacking, conversations with ranchers indicate that new lands are now being brought into production as the cost of hay increases. This has been observed on Middle Fork Burns Creek and Bluff Creek in Dawson County.

In the Burns Creek-Thirteenmile Creek KCLA scattered blocks of land are hayed along North Fork Burns Creek (Plates 24, 26). Most hay is raised on the high terraces where about one cutting is obtained per year. On lower Middle and South Forks of Burns Creek (Plates 25, 27), much of the alluvial valley floors are in hay production or are being brought into production. Conversations with ranchers indicate that these lands are crucial to success of the ranchers of this area. Scattered valley floor areas in the upper portions of the Middle and South Forks of Burns Creek are cropped. This is an area of extensive wheat farming and interest in hay cropping may be less than in ranching areas. Little hay cropping is done in the Thirteenmile Creek drainage (Plates 21, 23). Some portions of the South Fork of Fox Creek (Plate 20) are used to produce alfalfa. Irrigation in the Yellowstone River Valley is extensive but is not for hay production.

No flood irrigation from Redwater River onto its terraces has been observed anywhere in the study area. Lower terraces which might well be suited for flood irrigation have been mapped as the alluvial valley floor. Floodflows from tributaries to the Redwater, however, are extensively diverted onto Redwater terraces at Duck Creek, Buffalo Springs Creek, and Dry Ash Creek. Haying also takes place on several southeastward flowing tributaries and along Cow, Duck, and Horse Creeks (Plates 15, 19, 9). Ditch irrigation onto high terraces and nearby upland plains also occurs.

On Timber Creek in the western McCone study area little hay is raised (Plate 1). On Nelson Creek, however, significant acreage of alluvial valley floor is used for hay even where soil salinity is high (Plate 6). Also, parts of Dirty Creek are used for haying (Plate 7). In this study area, valley floors were the only sites where hay production was found to take place.

Irrigation is extensive along Little Dry Creek in Garfield County (Plate 14). This land is used for hay and wheat production. Lands along the mainstem of Timber Creek, and in the headwaters of Uall and Crow Rock Creeks are flood irrigated for hay. No hay production occurs on the mainstems of Uall or Crow Rock Creeks (Plate 16). Salinity is high in the channels and the upper terraces are cropped for wheat.

Property Value

The Montana Department of Revenue, Property Valuation Division, has assessed the value of all lands with the state. This assessment serves as the basis for taxation. Grazing lands are assessed relative to their productivity. Grades of grazing lands found within the study area are:

Grade	Hectares needed for 10-month grazing season per 454 kg steer or equivalent
G2B	9-11ha
G3	11-15ha
G4	15-22ha
G5	23-40ha

Wild hay land is also classed on productivity. Grades of wild hay lands found within the study area are:

Grade	Metric tons of hay/hectare
W5	2.24-3.14
W6	1.12-2.01
W7	less than 1.12

Assessments were completed in 1962 and reflect land conditions at that time.

The assessment records for Dawson County were compared with the indicated alluvial valleys using 1:24,000 scale base air photos. Thus, an overall evaluation of land values in the Burns Creek-Thirteenmile Creek KCLA could be made. Over ninety-five percent of the mapped alluvial valley floors in the KCLA are classed as G2B lands. Upland areas range in classification from G2B to G5 with most lands being G3 and G4. In most areas where wheat farming is the predominanat land use, G2B lands exist in wide bands along streams, beyond the limits of the alluvial valley floors. Wild hay lands are sporadically located along streams and range in classification from W5 through W7.

In contrast, little land in the Weldon-Timber Creek or Redwater River strippable coal areas is classed G2B. Most of the terrace lands are classed G3 or G4. Time did not permit mapping to compare lowland and upland areas. Hay lands are classed W5 or W6.

Thus, it can be seen, that for purposes of land taxation, Dawson County alluvial valley floors are classified as the most productive rangeland in the county, and that their productivity is rated higher than valley bottom lands of McCone County. Productivity of wild hay lands is about the same in both counties.

CONCLUSIONS

This report has indicated the importance of valley floor areas for the production of forage and in some localities, for the production of hay. (See page 35.) This report has also shown that substantial coal reserves with high potential for development exist in areas not overlain by alluvial valley floors or their related alluvial deposits. (See page 18.) Thus, if alluvial valley floors, and their related alluvial deposits, were protected from surface coal mining, extensive reserves of coal could still be extracted.

Reconnaissance identification of alluvial valley floors is not a substitute for detailed ground water studies to actually identify the nature of the alluvial ground water system of concern to a particular mining operation. Drilling of observation wells could document not only the level (elevation) of the alluvial ground water table, but also the quantity of water flowing in the alluvium and its quality.

This reconnaissance study is also no substitute for a detailed economic assessment of these valley floor areas. Some mapped alluvial valley floors in these study areas provide the critical supply of water, forage, and/or winter feed to the ranching operation using the valley lands. Other valley floors are viewed by ranchers as a future source of hay production. Some valley floor areas are little used by livestock but supply important wildlife habitat. No assessment has been made to date of the economic importance of these areas; no studies have been made of how selected ranchers would be affected if the valley floors they utilize were to be lost from production due to failure of revegetation efforts or detrimental off-site impacts. No assessments have been made of the importance of valley floor habitat to the maintenance of certain wildlife populations.

The results of this report show that further reconnaissance mapping of alluvial valley floors might better use characteristic valley bottom grass species, and observed use of lands for haying, as indicators of the existence of alluvial valley floors. Indicator grass species, when identified by a competent field botanist in late spring and early summer, are believed to provide an excellent characteristic to establish that certain valleys receive greater than average moisture. Existence of similiar communities on higher terraces would justify inclusion of these areas within the alluvial valley floor.

If time does not permit extensive field work, it seems that identification of hayed lands on air photos provides an excellent indicator of which valleys have the potential for development of that land use. Most alluvial valley floors mapped in this study area already are hayed in part.

This report has identified extensive parts of valley floors where saline soils are predominant. These valley floors serve as important sources of forage production, where overgrazing has not reduced the range quality to inland saltgrass dominance. Some of these saline soil areas are also used to produce hay. Even so, the SCS does not recommend tillage of these saline soils.

Proposed mining activities in these areas will have to address these saline conditions. Special handling of saline materials might permit its burial and improve the quality of ground waters in the alluvial system. It is also possible that mining activity might detrimentally affect these saline valley floors if even greater saline concentrations were the result of mining disturbance. In this latter case, downstream landowners who might be using valley floors for haying might suffer productivity losses from an increasingly saline water supply.

Future research concerning alluvial valley floors in the semi-arid west and the impacts of surface mining should focus on identifying the critical geologic, hydrologic, biologic factors supporting the agricultural uses of these lowland and terrace areas. Identification of the factors will assist in protection of alluvial valley floors by describing the conditions that must be recreated after mining. The resulting information can be used to establish mining and reclamation guidelines which enable policy makers to determine suitability of alluvial valley floors for future mining.

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Two people were especially important to the project. John Herrin served as field assistant in August and September, 1976, completed the initial interpretation of valley floors in the Burns Creek drainage, and assisted in the McCone County work. Barbara Rusmore advised on report preparation and editing, completed all drafting work, and provided beneficial support during the project period.

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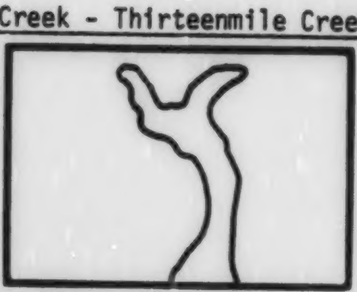
APPENDIX I

Area 1. Burns Creek - Thirteenmile Creek KCLA

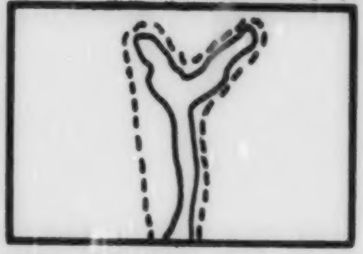
LEGEND

1:24,000 Topographic Maps
(Figures 3 - 13)

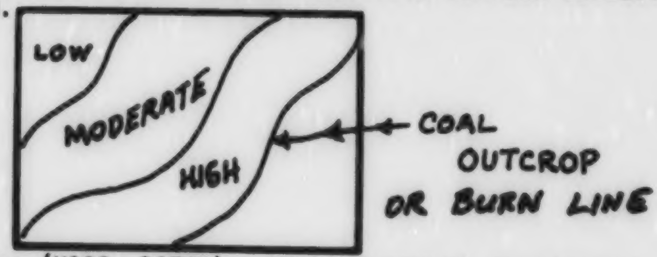
Burns Creek - Thirteenmile Creek KCLA



Alluvial Valley Floors. These are mapped as the low terrace, floodplain, and channel of major drainages and those minor drainages whose low terraces are either used in part for hay production or which have the potential for such use. These areas may include soils which have potential salinity problems. Areas less than 7 m in width are excluded.



Related alluvial Deposits. Recent (?) alluvial deposits of streams whose lowest terraces are mapped as alluvial valley floors. Includes surface colluvium probably underlain by alluvium.



Coal Potential Development Areas (USGS, 1976*). High Potential Development Areas: overburden 0-46 m thick and stripping ratio 10:1 or less. Moderate Potential Development Areas: overburden 46-61 m and stripping ratio 20:1 or less. Low Potential Development Areas: overburden greater than 61 m and stripping ratio greater than 20:1. Note: Where High Development Areas are bounded by areas not designated (blank), the coal outcrops and is not contained in the undesignated area.

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* U.S. Geological Survey. 1976. Coal development potential map: Burns Creek-Thirteenmile Creek Known Coal Leasing Area, Dawson and Richland Counties, Montana. Unpublished.

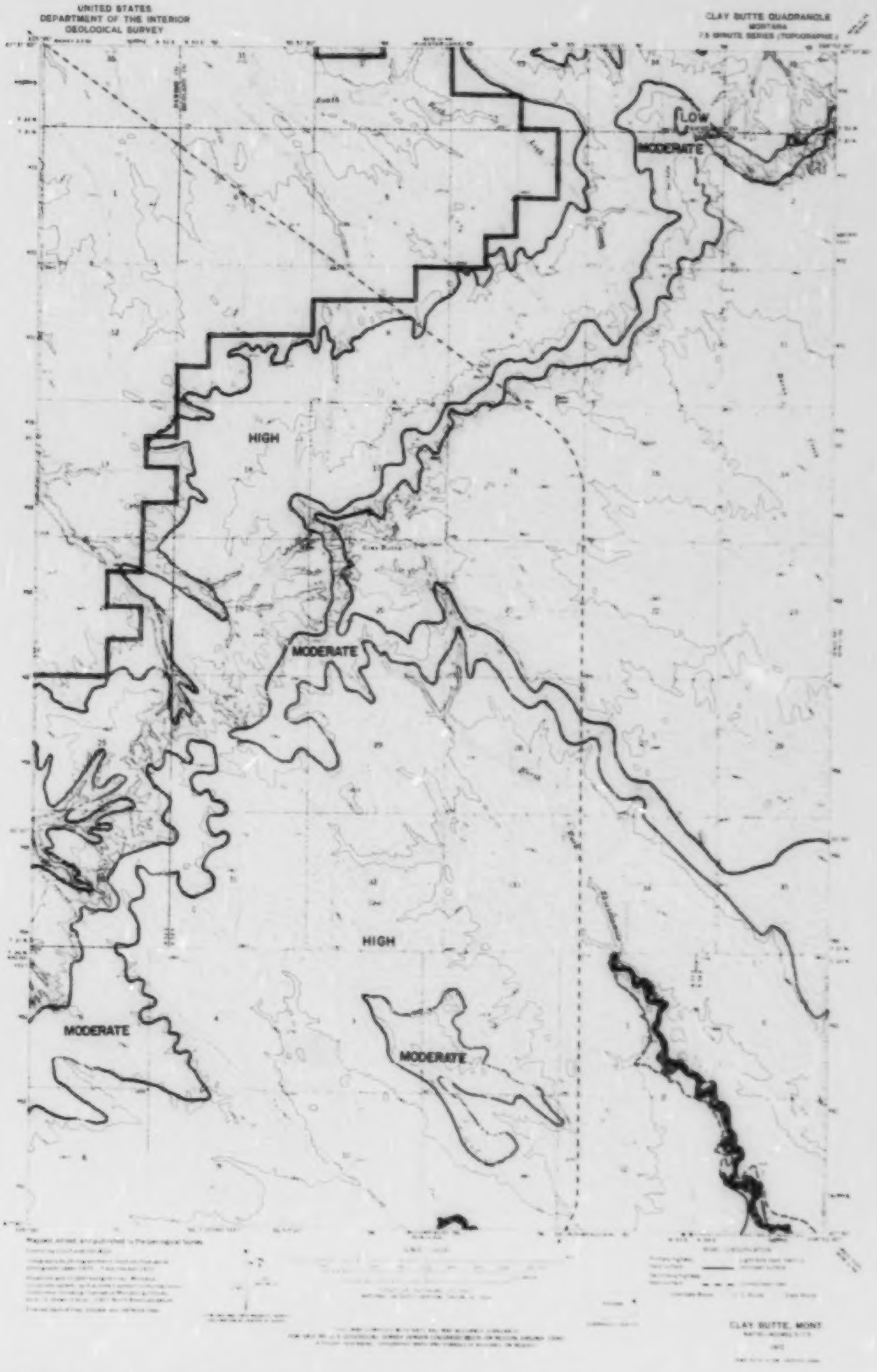
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CLAY BUTTE QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)
LOW
MODERATE
HIGH
MODERATE
HIGH
MODERATE
MODERATE
CLAY BUTTE, MONT.

FIG. 3 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES CLAY BUTTE QUADRANGLE, MT

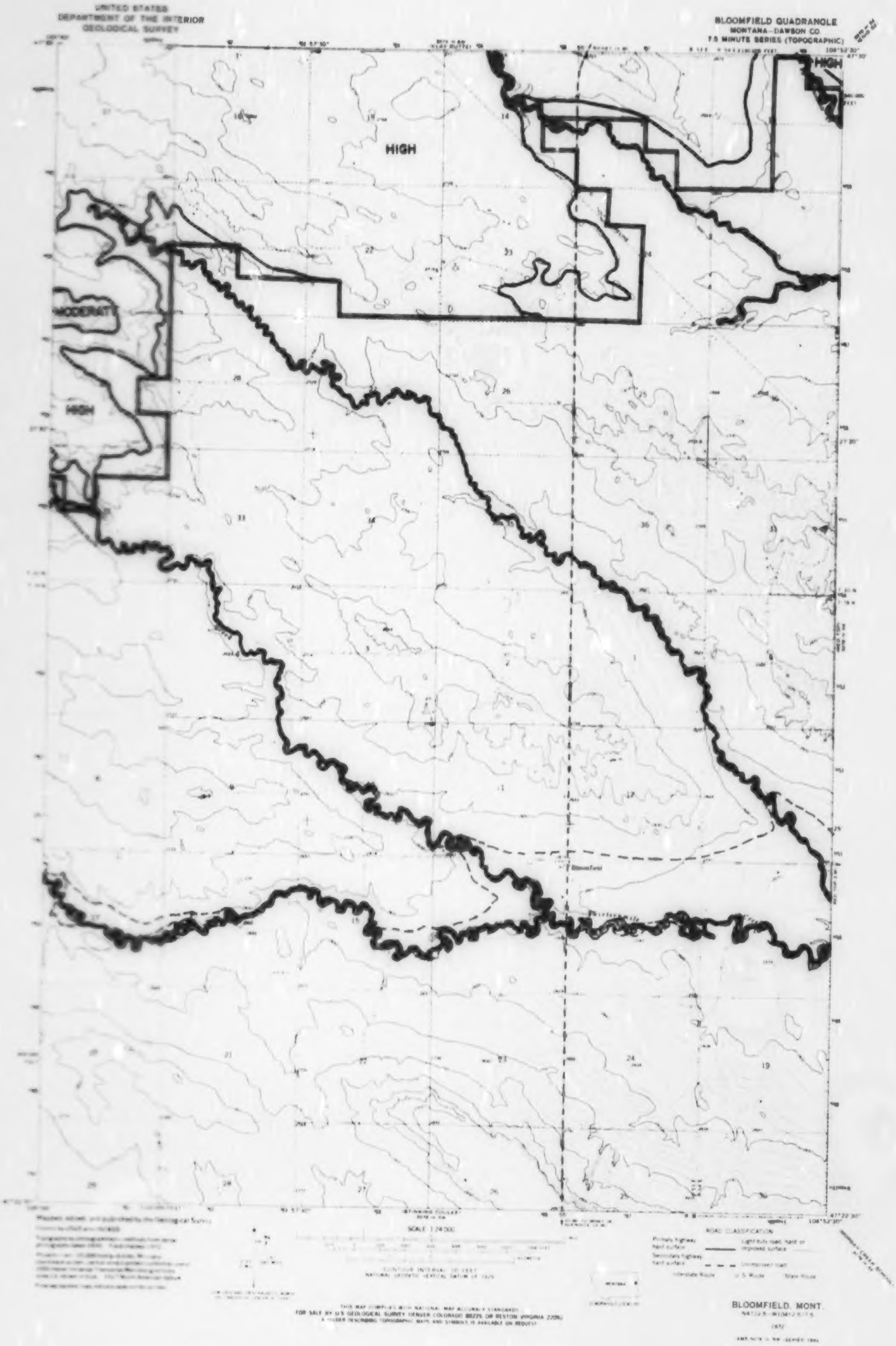
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BLOOMFIELD QUADRANGLE
MONTANA–DAWSON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
HIGH
HIGH
MODERATE
HIGH
47°22'30"
104°52'30"
ROAD CLASSIFICATION
Primary highway, hard surface
Light-duty road, hard or improved surface
Secondary highway, hard surface
Unimproved road
Interstate Route
U.S. Route
State Route
BLOOMFIELD, MONT.
1972

FIG. 4 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES BLOOMFIELD QUADRANGLE, MT

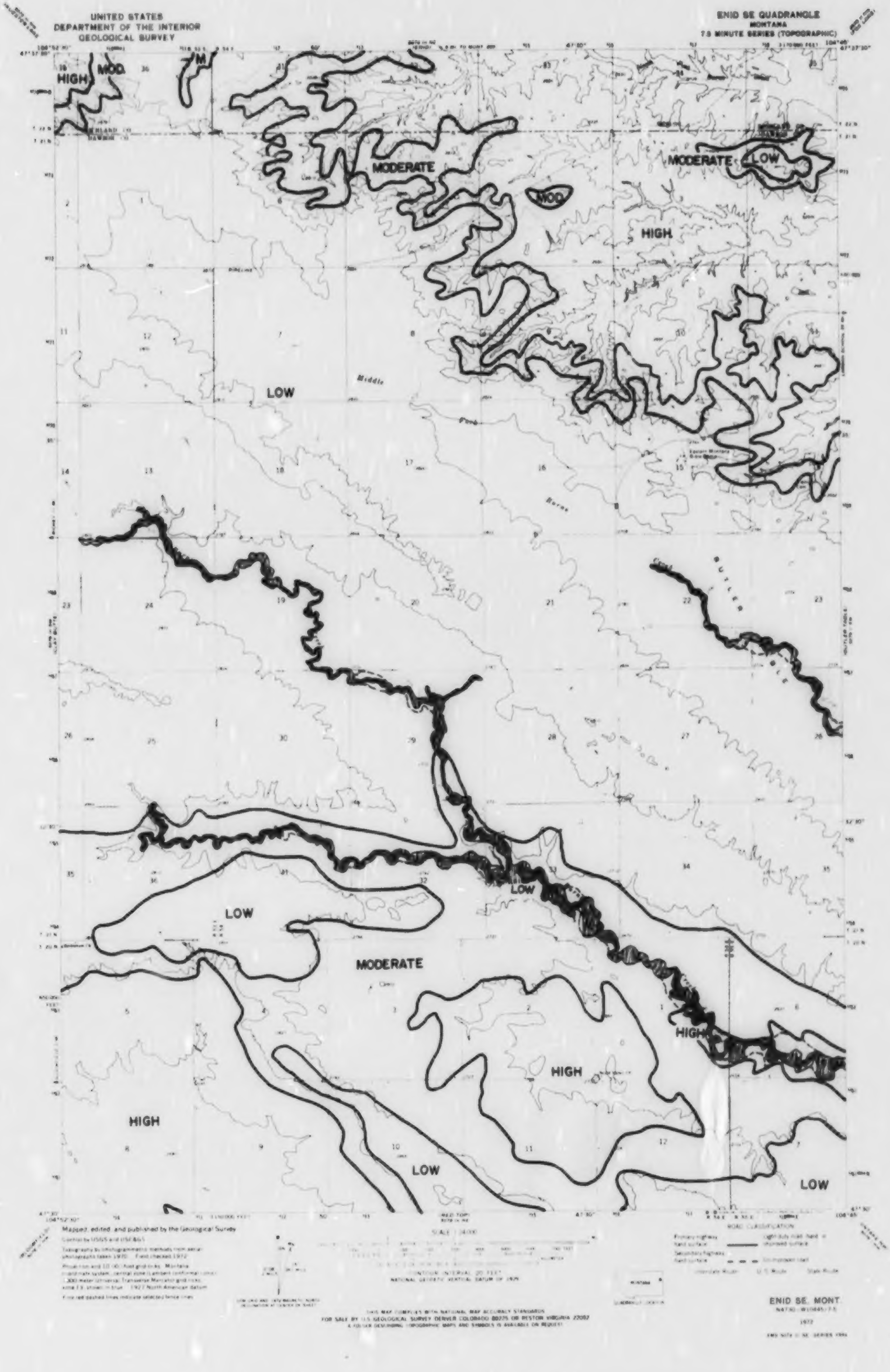
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
ENID SE QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)
HIGH
MOD.
M
MODERATE
MOD
MODERATE
LOW
HIGH
LOW
Middle
Pine
Butler
LOW
LOW
MODERATE
HIGH
HIGH
HIGH
LOW
LOW
ENID SE, MONT.
1972

Fig. 5 Location of Alluvial Valley Floors and Related Features Enid SE Quadrangle, MT

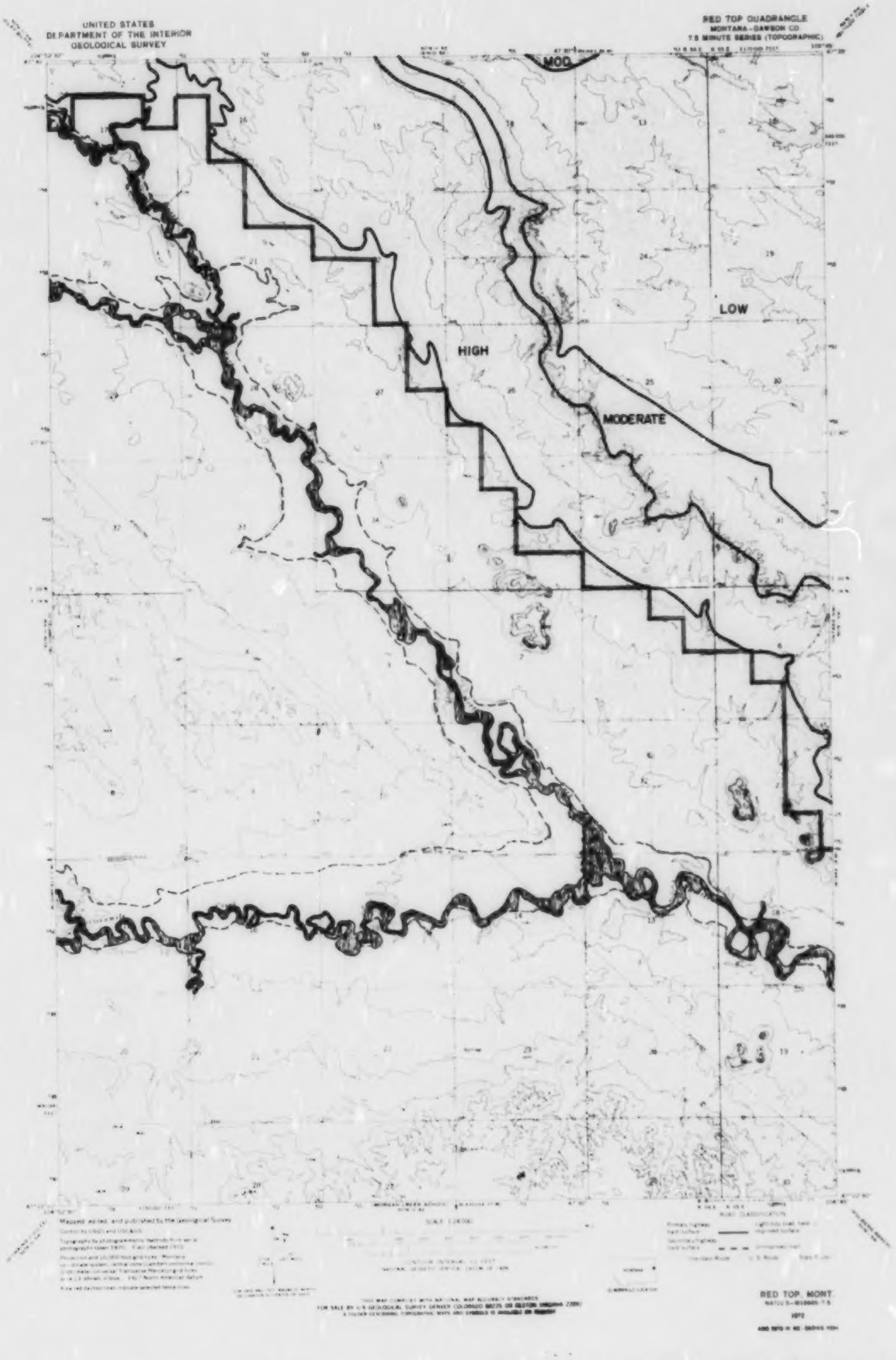
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
RED TOP QUADRANGLE
MONTANA–DAWSON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
MOD
HIGH
LOW
MODERATE
RED TOP, MONT.

Fig. 6 Location of Alluvial Valley Floors and Related Features Red Top Quadrangle, MT

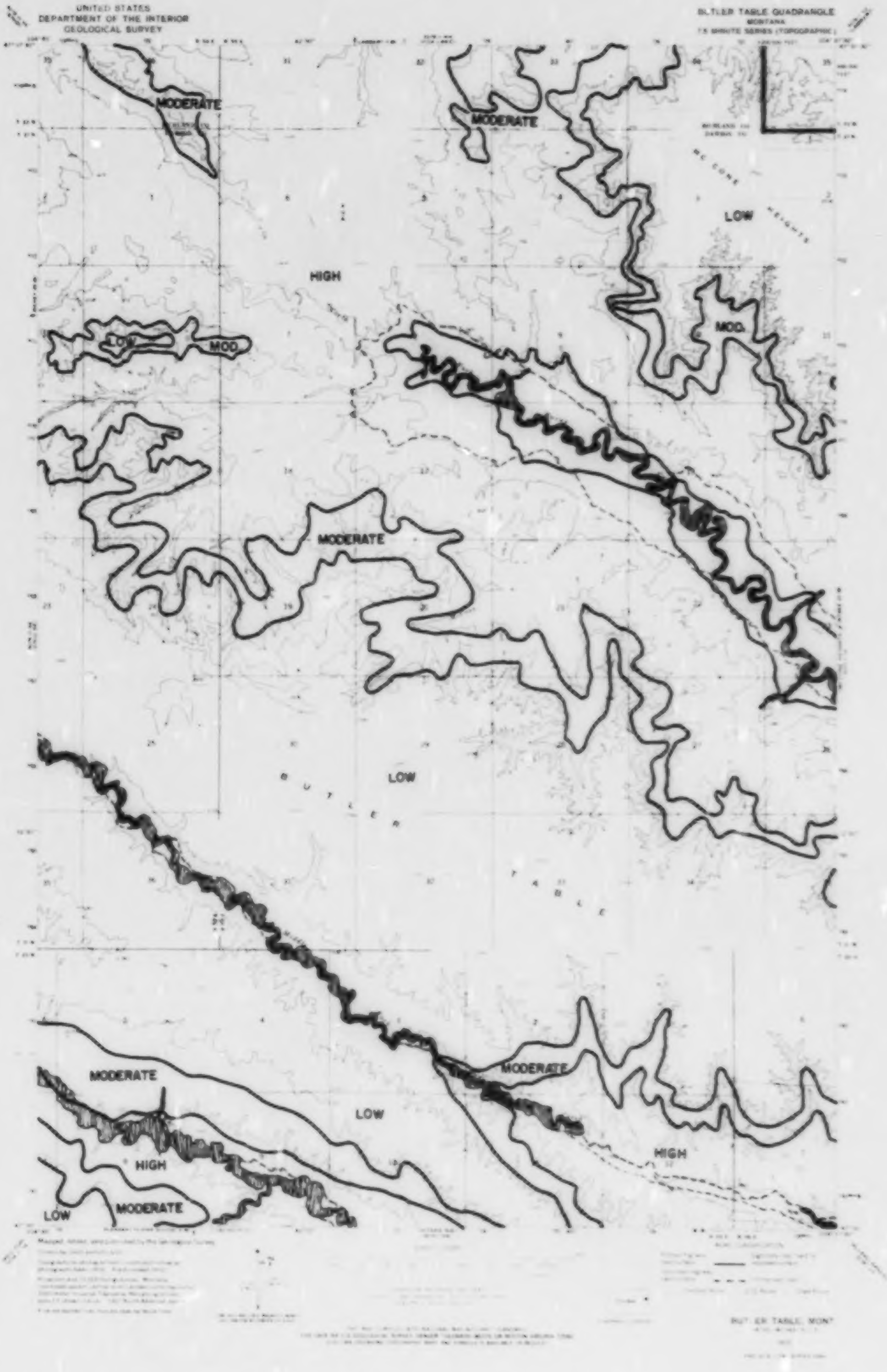
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BUTLER TABLE QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)
MODERATE
MODERATE
LOW
HIGH
LOW
MOD.
MOD.
MODERATE
LOW
BUTLER TABLE
MODERATE
MODERATE
LOW
HIGH
HIGH
LOW
MODERATE
BUTLER TABLE, MONT.

FIG. 7 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
BUTLER TABLE QUADRANGLE, MT

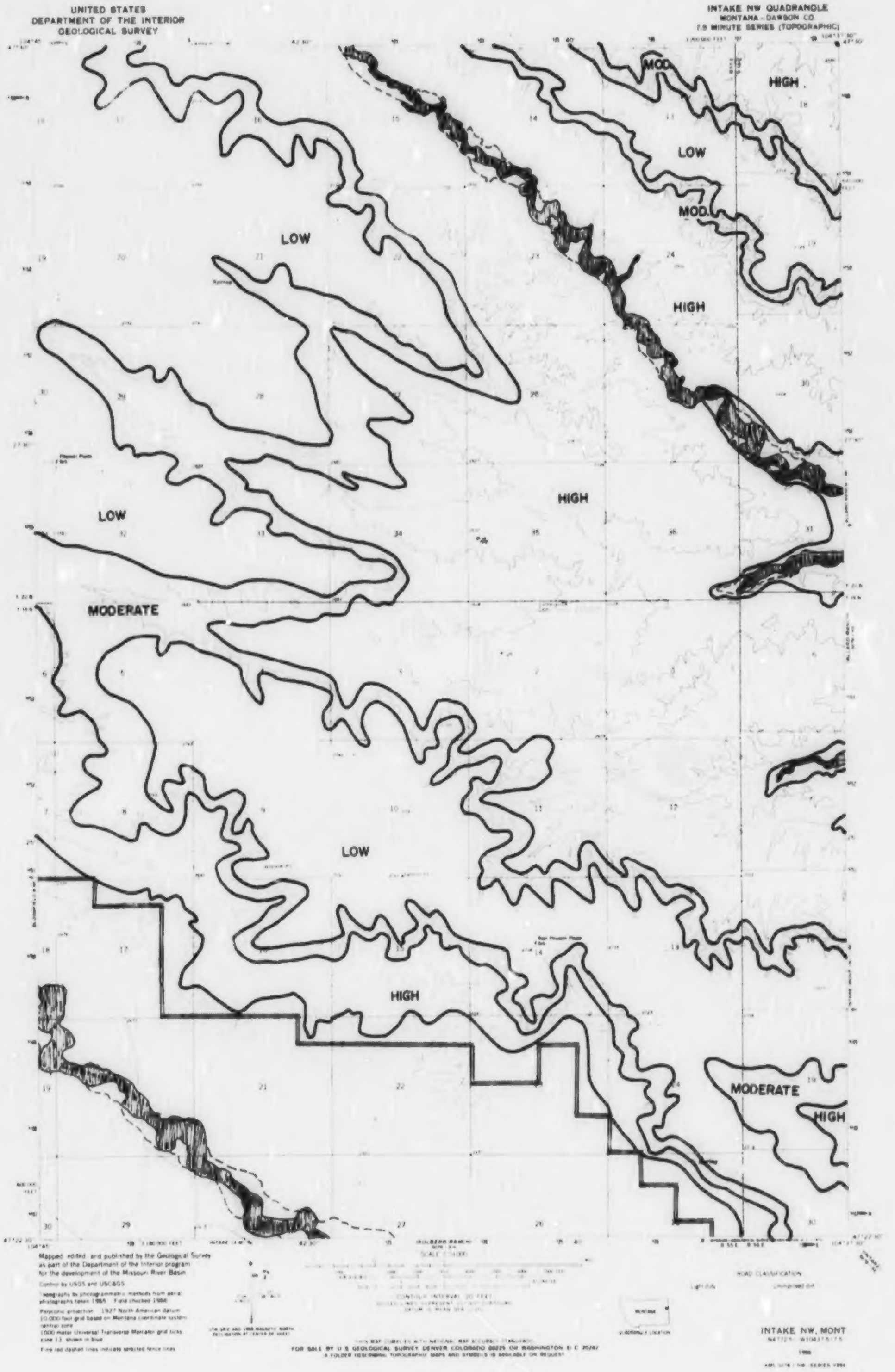
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
INTAKE NW QUADRANGLE
MONTANA - DAWSON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
MOD.
HIGH
LOW
MOD.
LOW
HIGH
LOW
HIGH
MODERATE
LOW
HIGH
MODERATE
HIGH
INTAKE NW, MONT

FIG. 8 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
INTAKE NW QUADRANGLE, MT

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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4. TITLE AND SUBTITLE ALLUVIAL VALLEY FLOORS IN EAST-CENTRAL MONTANA AND THEIR RELATION TO STRIPPABLE COAL RESERVES Reconnaissance report		5. REPORT DATE January 1977 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Jack Schmidt		8. PERFORMING ORGANIZATION REPORT NO. OEA 76-1
9. PERFORMING ORGANIZATION NAME AND ADDRESS Montana Department of Natural Resources Water Quality Bureau and Montana Energy Advisory Council		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS EPA, Office of Energy Activities 1860 Lincoln St., Suite 10 Denver, Colorado 80295		13. TYPE OF REPORT AND PERIOD COVERED Information 1976 14. SPONSORING AGENCY CODE EPA - Region VIII

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This reconnaissance study indicates that small percentages of strippable coal underlie the valley floors of east central Montana. Extensive coal reserves underlie upland areas and small tributary streams. Valley floors serve an important role in the local economy and are the most productive lands of the region. They are primarily high-quality sources of range forage and secondarily produce harvestable hay crops.

Stream channels, floodplains, and low terraces were mapped as alluvial valley floors in those valleys used for hay production or which appeared to have the potential for such use. This mapping is considered to be consistent with the previous work of Malde and Boyles (1976) and the Environmental Protection Agency (1976). Alluvial valley floors overlie 1.5 percent of the tonnage of high potential development coal reserves of the Burns Creek-Thirteenmile Creek Known Coal Leasing Area (KCLA), Dawson and Richland Counties; 2.4 percent of the tonnage of the Weldon-Timber Creek strippable coal deposit, western McCone County; and 8 percent of the tonnage of the Redwater River strippable coal deposit, eastern McCone County. Mapping of the more extensive high terraces along

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Agriculture	Surface mining		
Alluvium	Soil		
Alluvial Valley Floors	Vegetation		
Coal	Reclamation		
Geology			
Grazing			
Hydrology			

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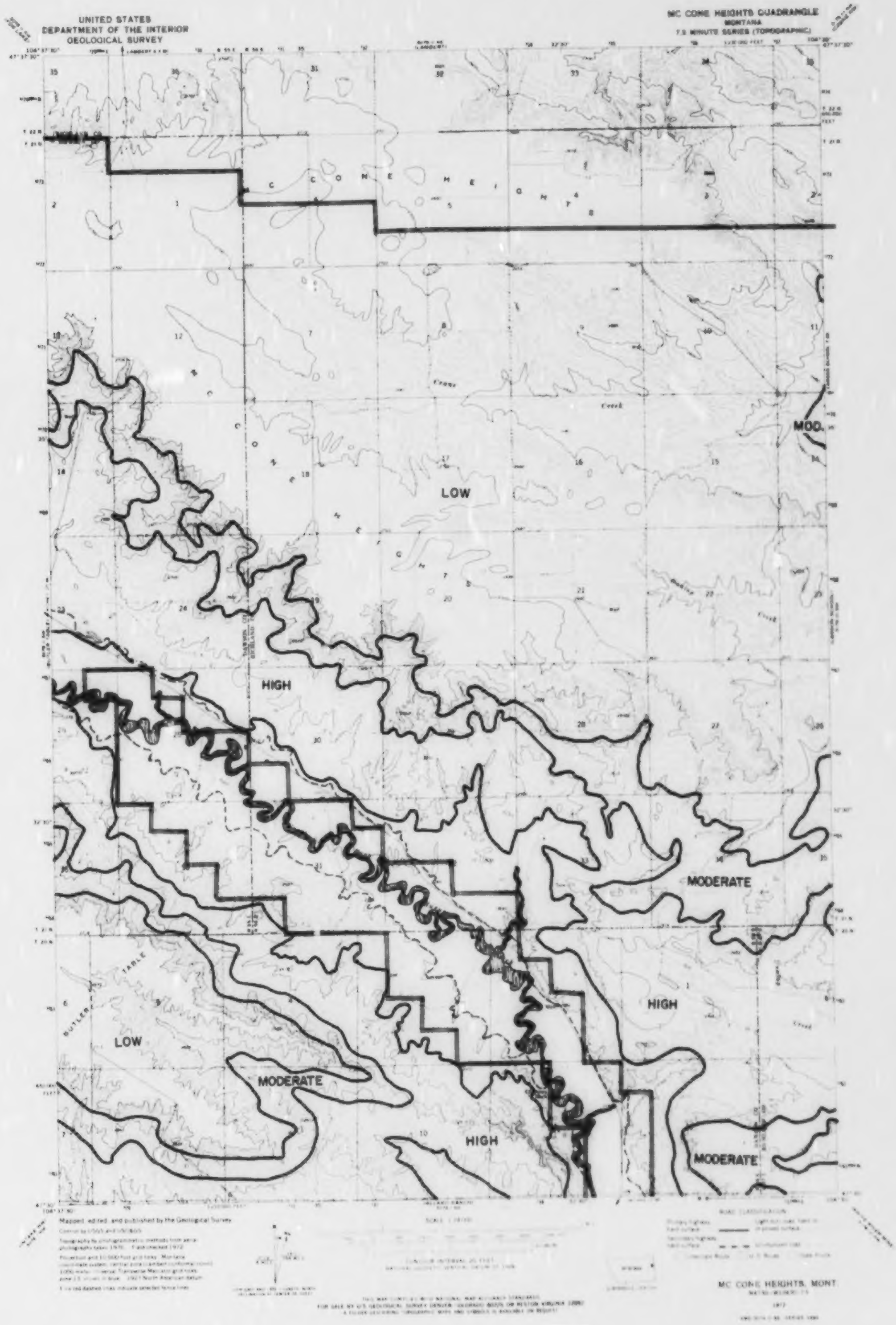

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MC CONE HEIGHTS QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)
LOW
HIGH
MODERATE
HIGH
LOW
MODERATE
HIGH
MODERATE
MOD.
MC CONE HEIGHTS, MONT.

FIG. 9 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES McCONE HEIGHTS QUADRANGLE, MT

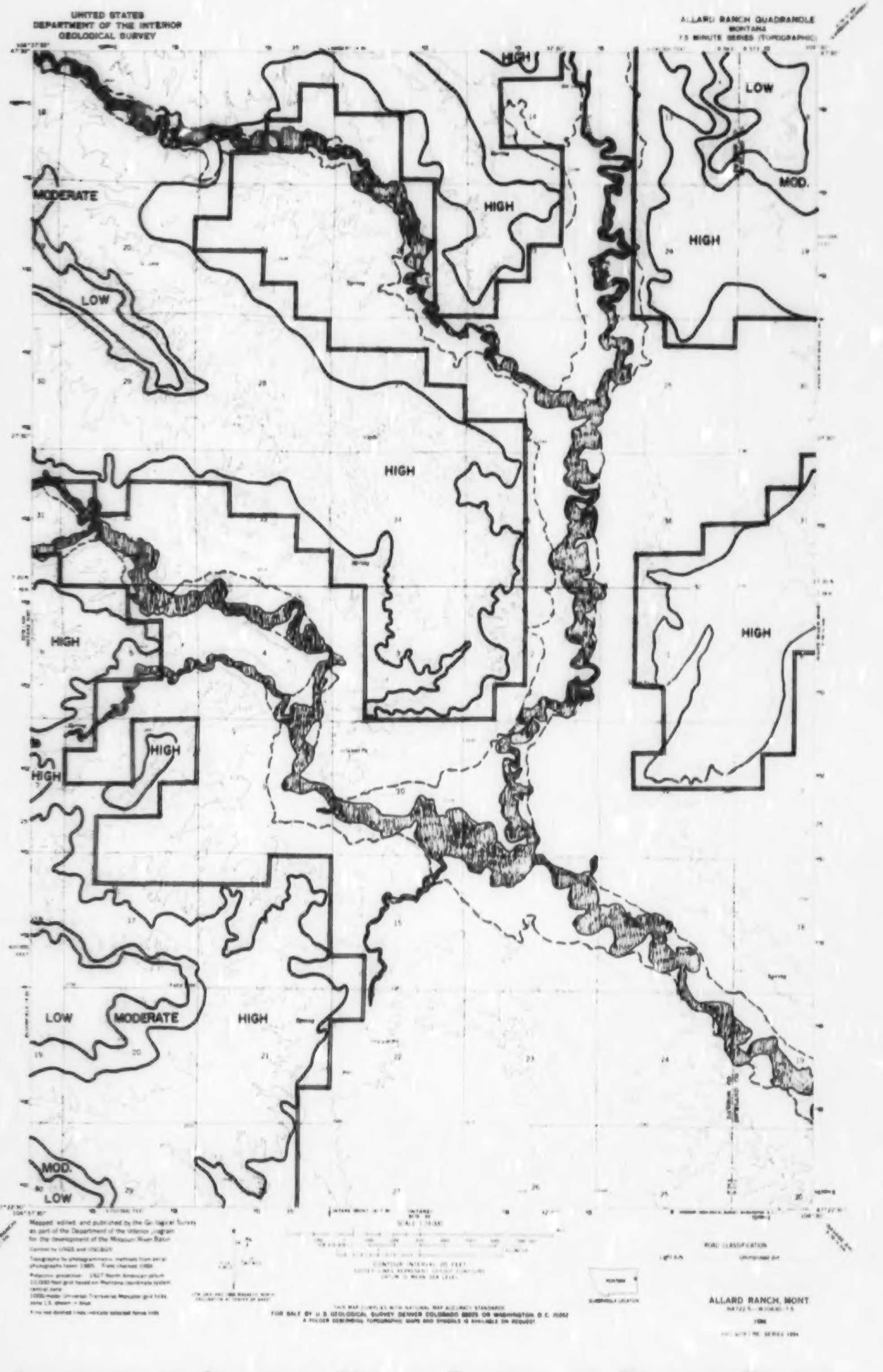

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
ALLARD RANCH QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)
HIGH
LOW
MOD.
MODERATE
HIGH
HIGH
LOW
HIGH
HIGH
HIGH
HIGH
HIGH
LOW
MODERATE
HIGH
MOD.
LOW
ALLARD RANCH, MONT.

Fig. 10 Location of Alluvial Valley Floors and Related Features
Allard Ranch Quadrangle, MT

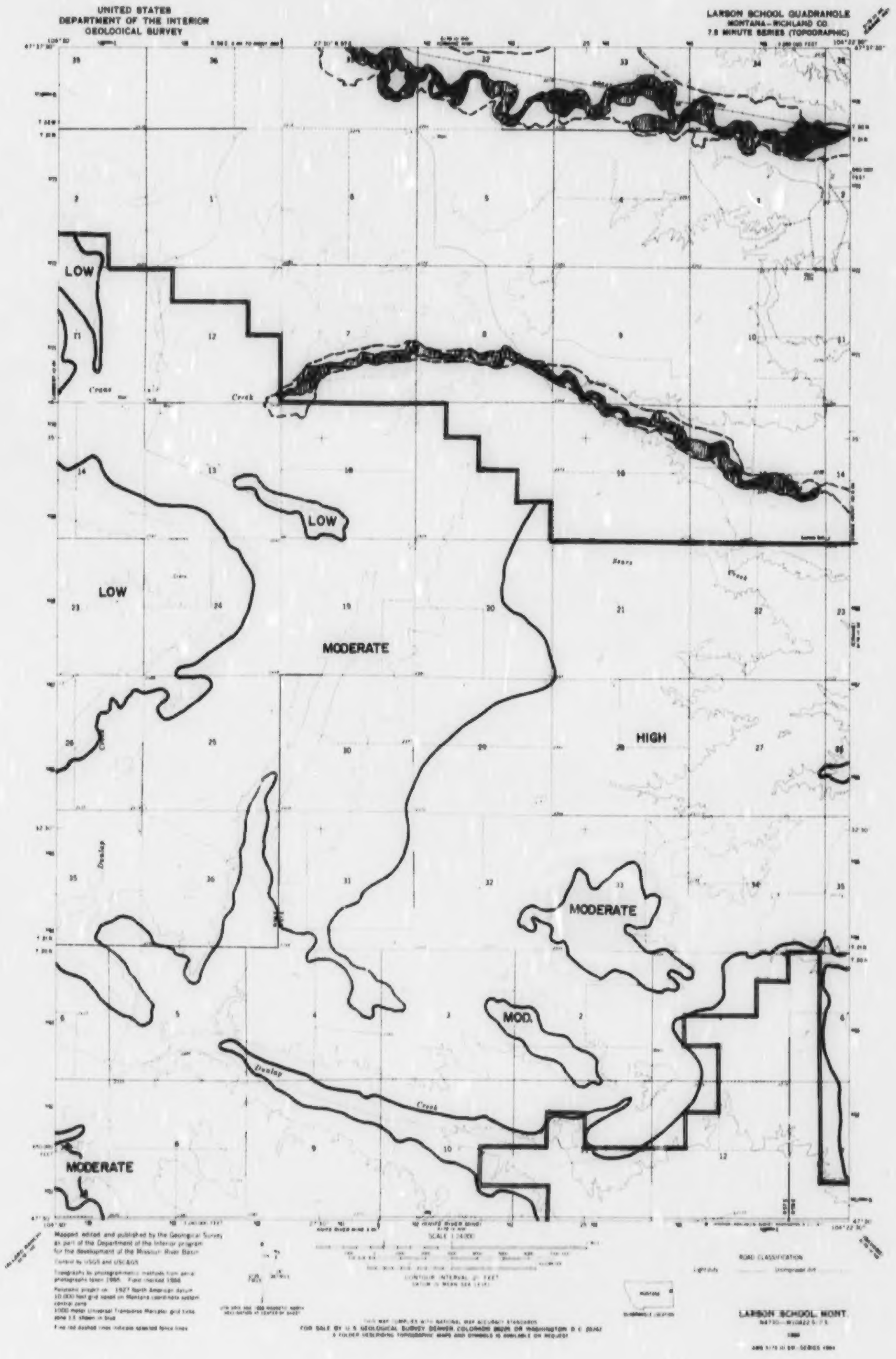

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
LARSON SCHOOL QUADRANGLE
MONTANA–RICHLAND CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
LOW
LOW
LOW
MODERATE
HIGH
MODERATE
MOD.
MODERATE
Crane Creek
Dunlap Creek
LARSON SCHOOL, MONT.

FIG. 11 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES LARSON SCHOOL QUADRANGLE, MT

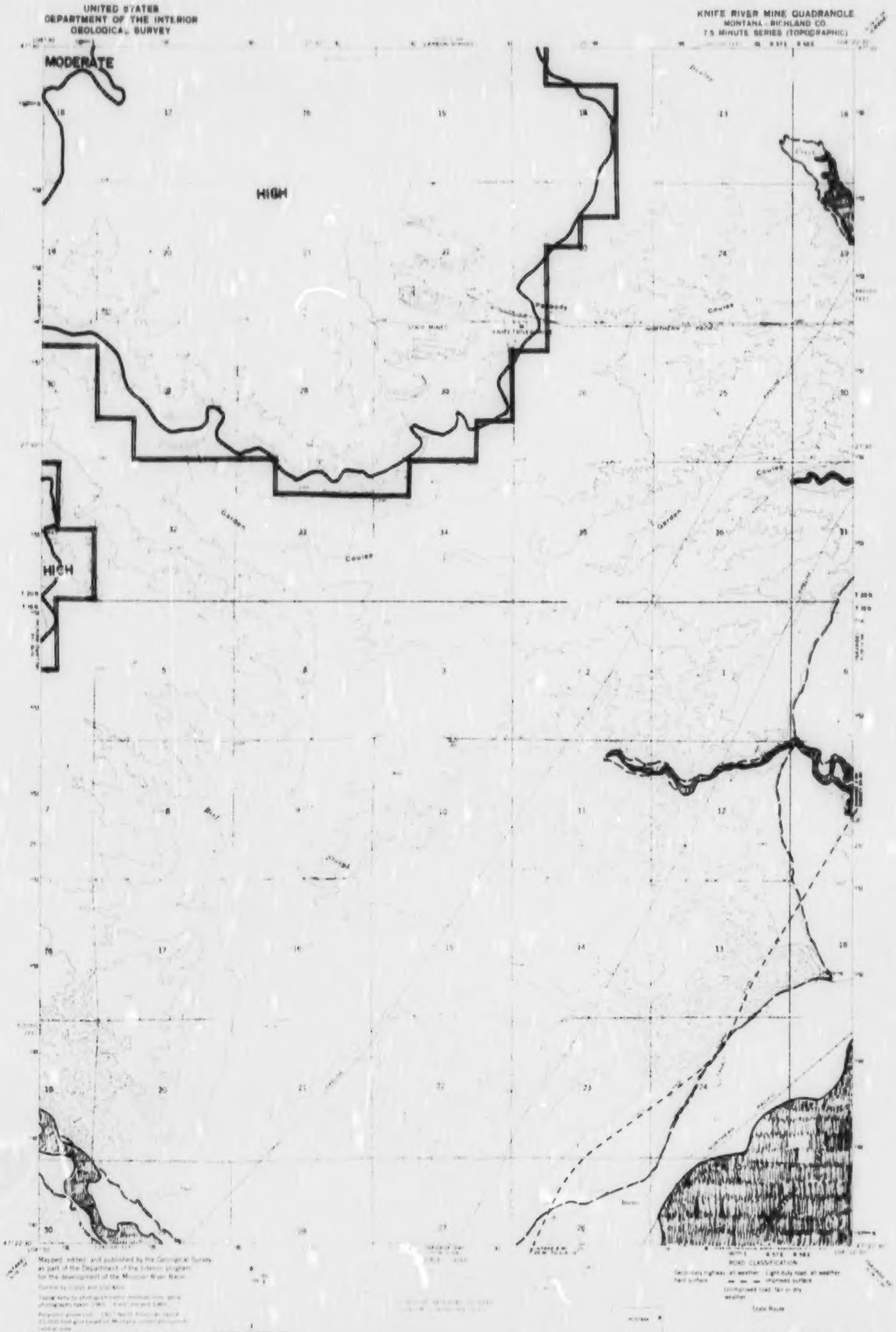

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
KNIFE RIVER MINE QUADRANGLE
MONTANA - RICHLAND CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
MODERATE
HIGH
HIGH
Garden
Coulee
Peabody
Coulee
KNIFE RIVER MINE, MONT.

FIG. 12 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES KNIFE RIVER MINE QUADRANGLE, MT

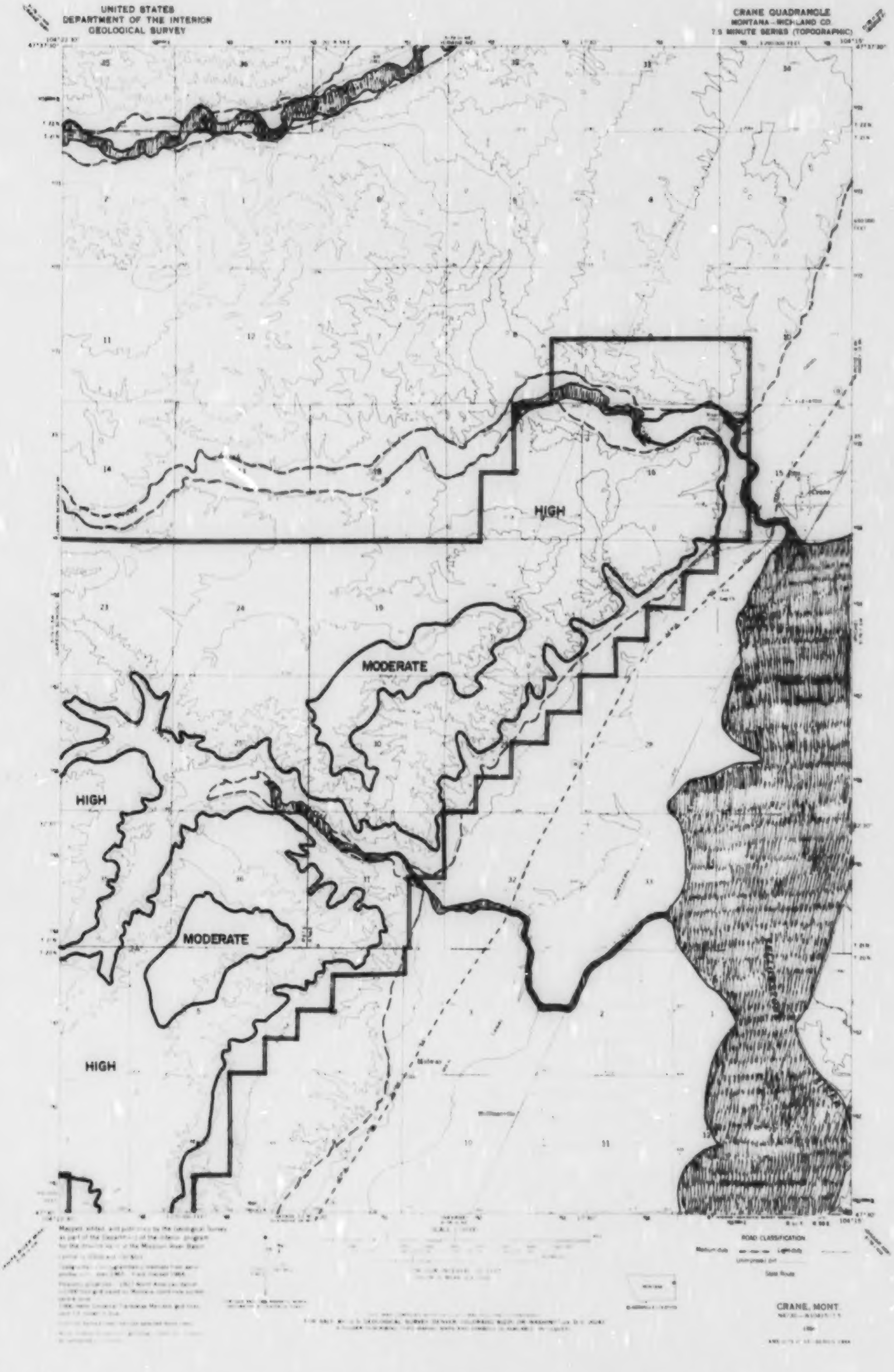
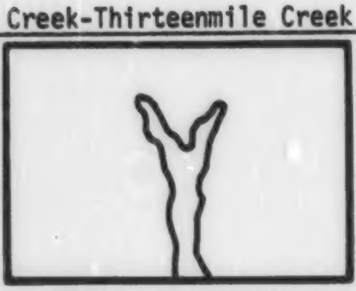

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CRANE QUADRANGLE
MONTANA - RICHLAND CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
HIGH
MODERATE
HIGH
MODERATE
HIGH
ROAD CLASSIFICATION
CRANE, MONT.

FIG. 13 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
CRANE QUADRANGLE, MT

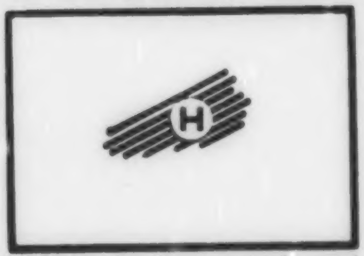
LEGEND

1:24,000 orthophoto quadrangle
maps (Plates 20-30)

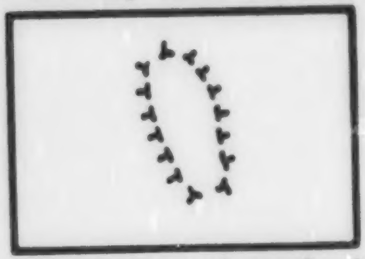
Burns Creek-Thirteenmile Creek KCLA



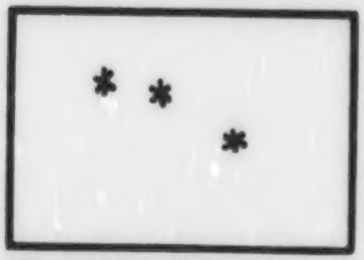
Alluvial Valley Floors. These are mapped as the low terrace, floodplain, and channel of major drainages and those minor drainages whose low terraces are either used in part for hay production or which have the potential for such use. These areas may include soils which have potential salinity problems. Areas less than 7 m in width excluded.



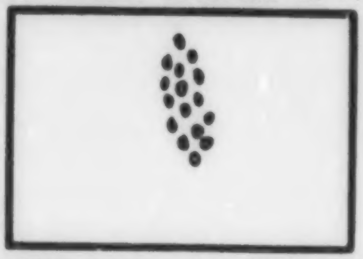
Hayed lands. Lands where hay was observed to be harvested, and lands irrigated for that purpose; irrigated lands mapped by the Montana Water Resources Board (1970), 1971a) except irrigated lands in the Yellowstone River valley; and lands appraised as wild hay lands under the Montana Agricultural Land Classification.



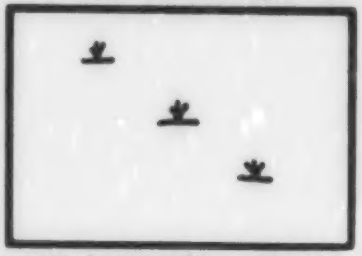
Saline Soils. "Nearly level areas of poorly drained...soil material that contain such large quantities of soluble salts and alkali that only the most salt-tolerant native plants can grow...Most areas have a water table at or within a few inches of the surface during most of the growing season in most years." (Holder and Pescador, 1976)



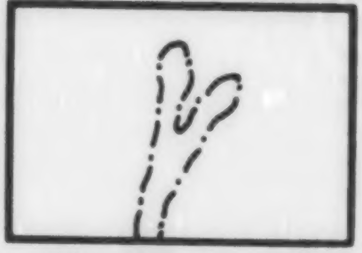
Salt Crusts. Surface salt crusts observed in field or on air photographs.



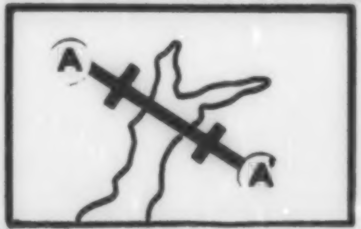
Gravel Areas. Valley bottom areas with high percentages of surface gravels, believed to limit agricultural use.



Marsh Areas. Wetland areas, usually not integrally related to the drainage system.



Wildlife Areas. Valley bottom lands, wider than 7 m, with high bluffs on their margins and generally covered with dense brush and trees.



Location of Transect. (See Figure 18-29) Fiducial marks indicate terminal points of measurements.

Plate 20 Location of Alluvial Valley Floors and Related Features
Clay Butte Orthophoto Quadrangle, MT

PLATE 21 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
BLOOMFIELD ORTHOPHOTO QUADRANGLE, MT

Plate 22 Location of Alluvial Valley Floors and Related Features
Enid SE Orthophoto Quadrangle, MT

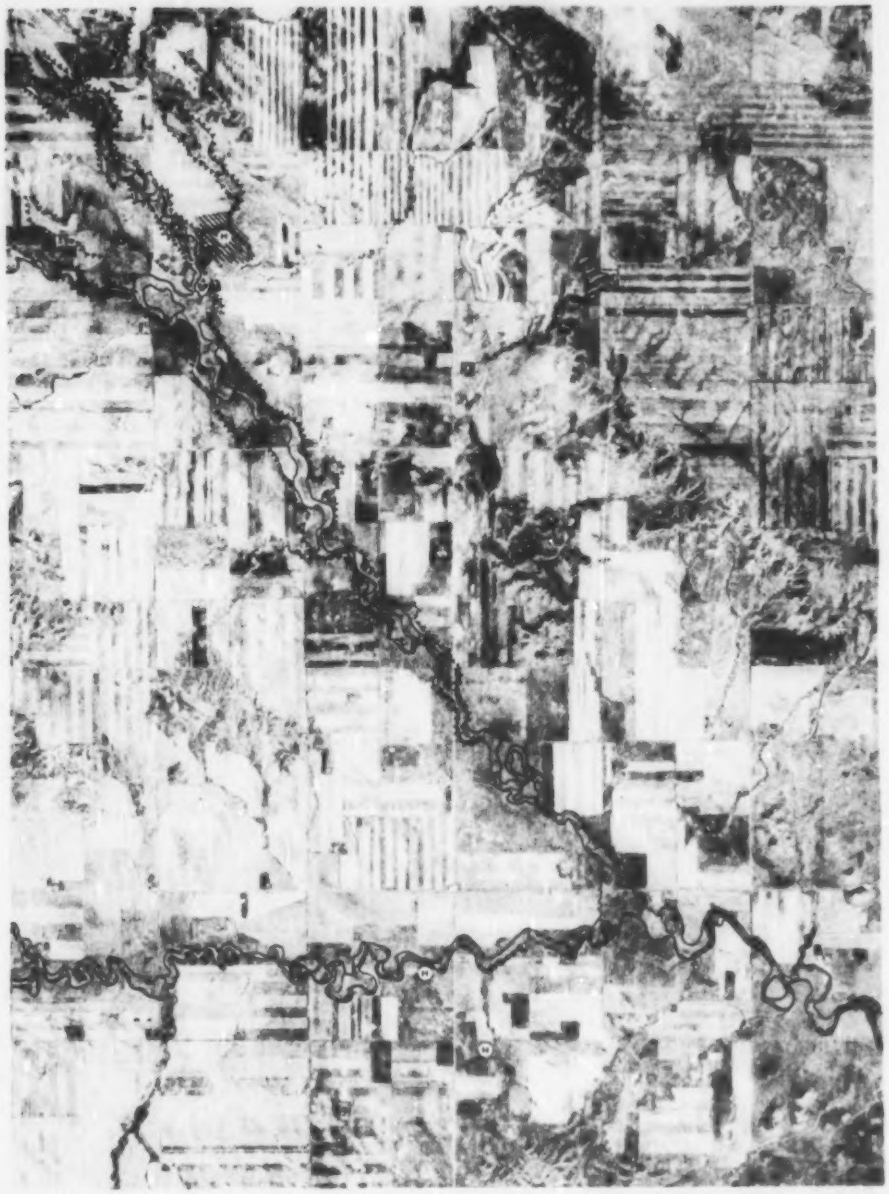


PLATE 23 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
RED TOP ORTHOPHOTO QUADRANGLE, MT

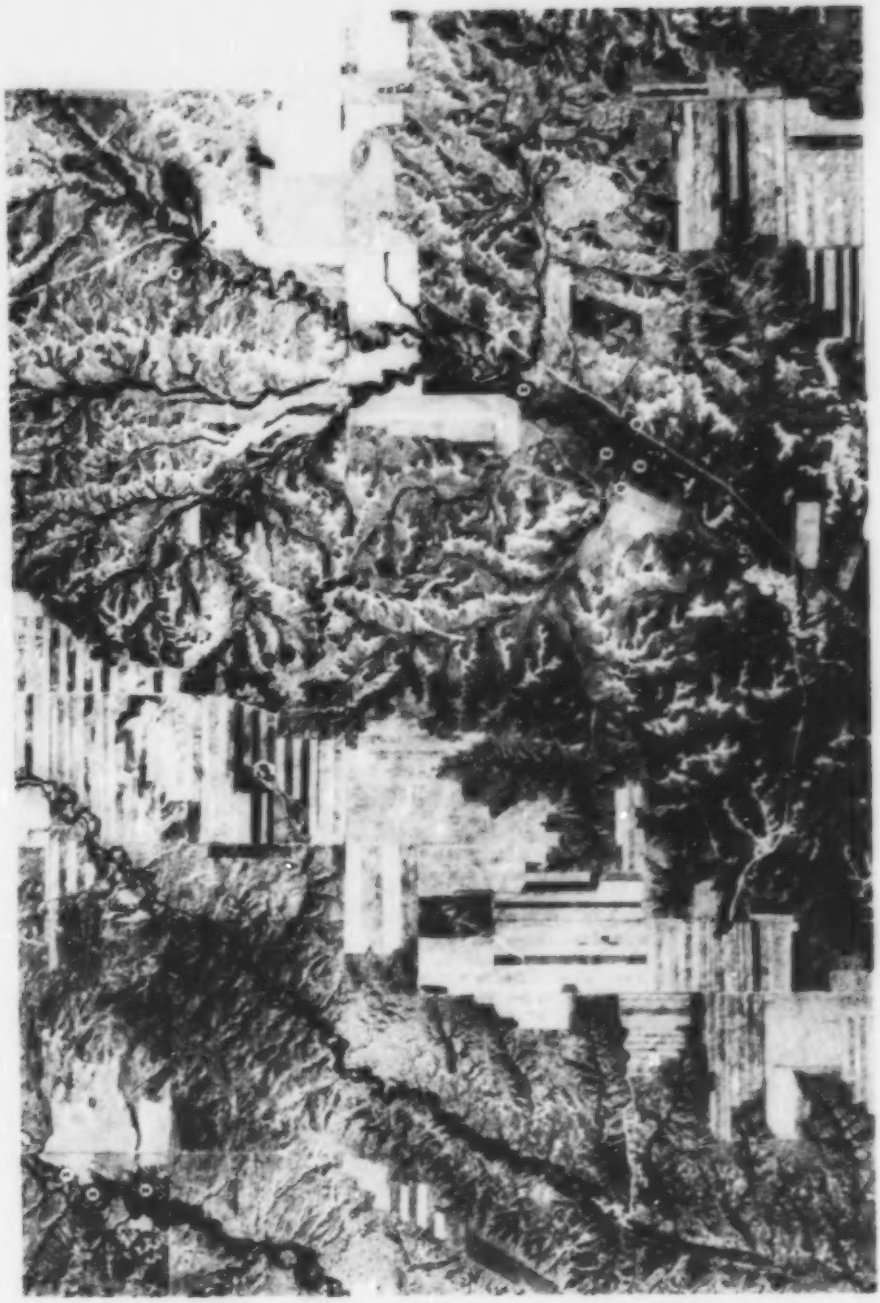


PLATE 24 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
BUTLER TABLE ORTHOPHOTO QUADRANGLE, MT

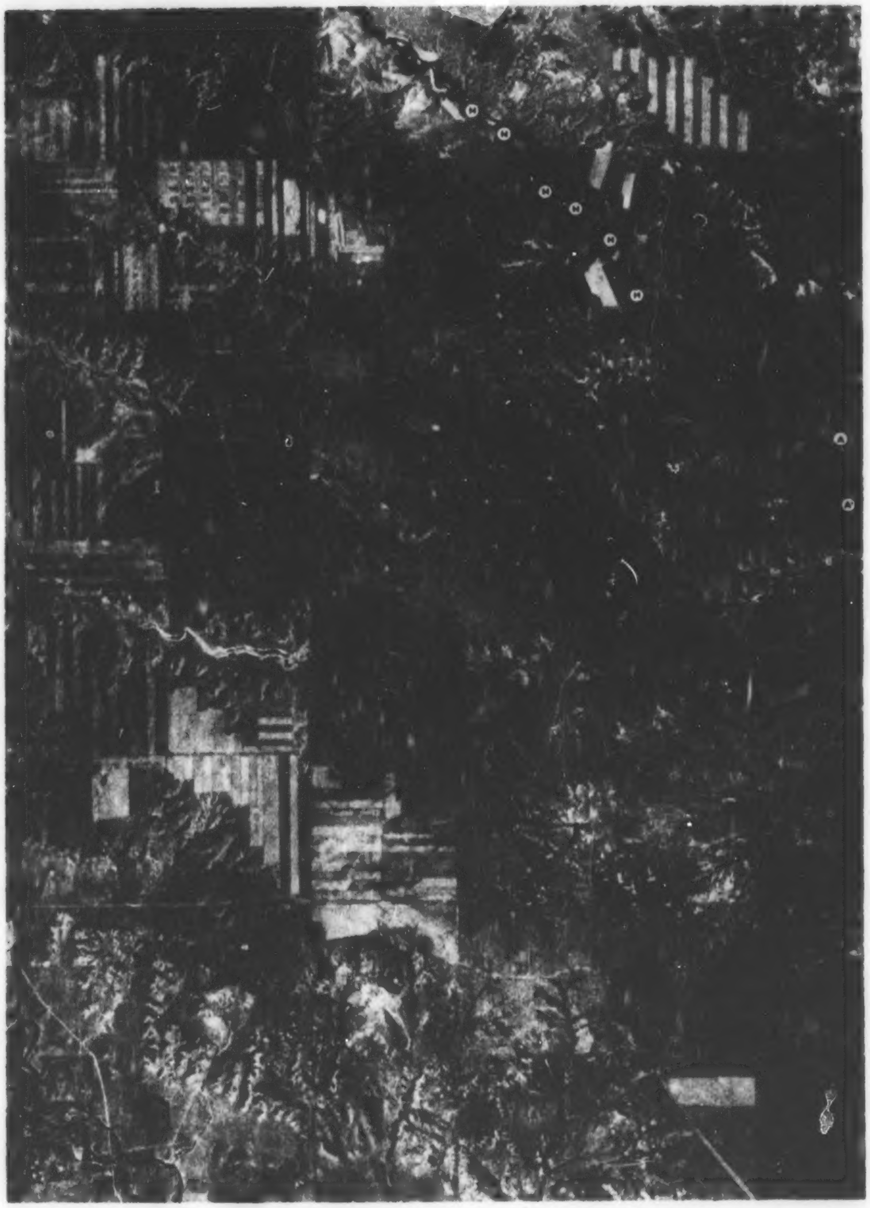


PLATE 25 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
INTAKE NW ORTHOPHOTO QUADRANGLE, MT

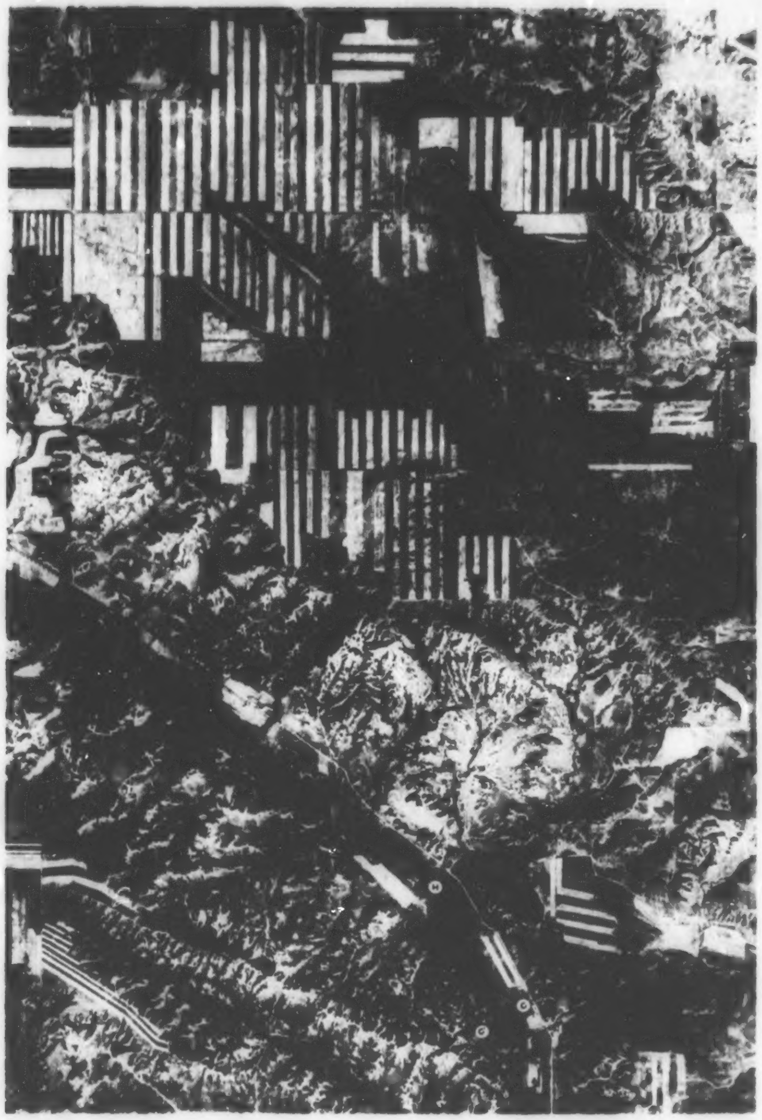


Plate 26 Location of Alluvial Valley Floors and Related Features
McCone Heights Orthophoto Quadrangle, MT

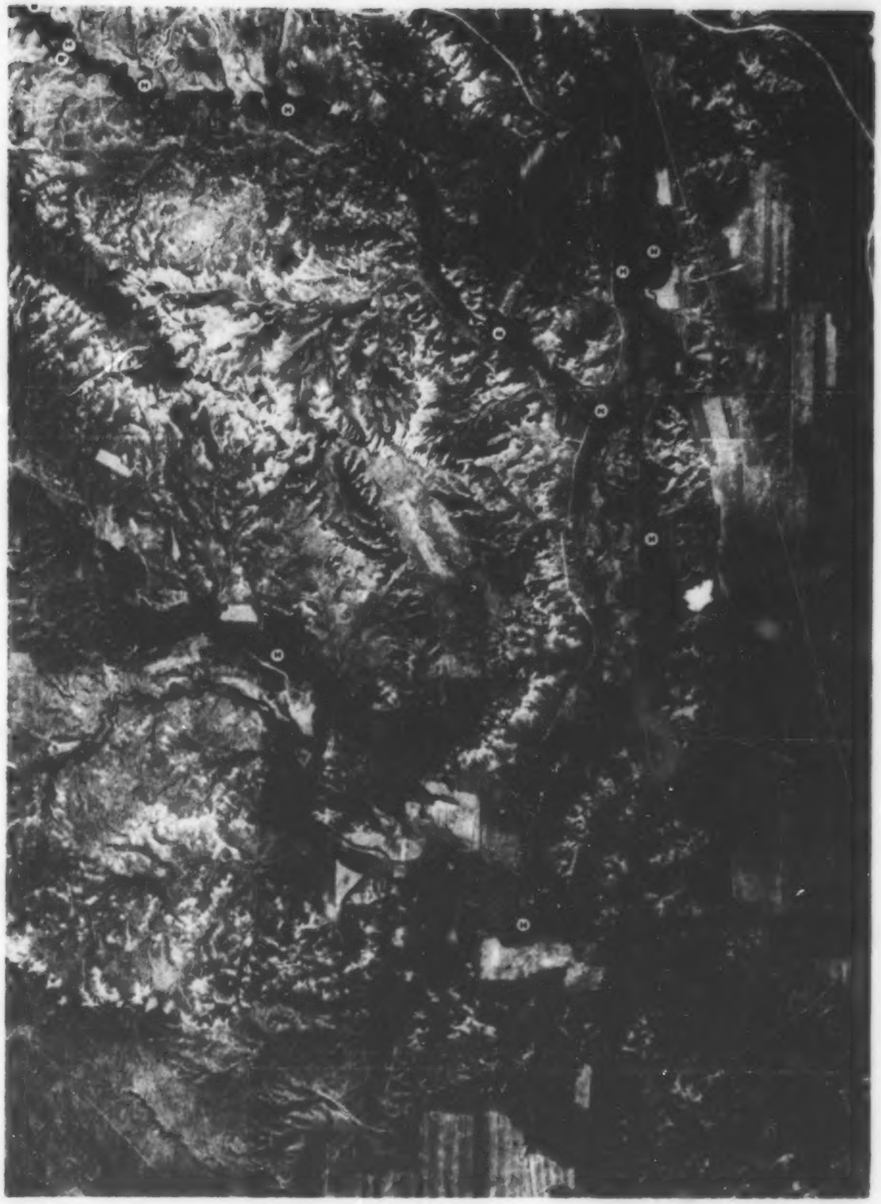


Plate 27 Location of Alluvial Valley Floors and Related Features
Allard Ranch Orthophoto Quadrangle, MT

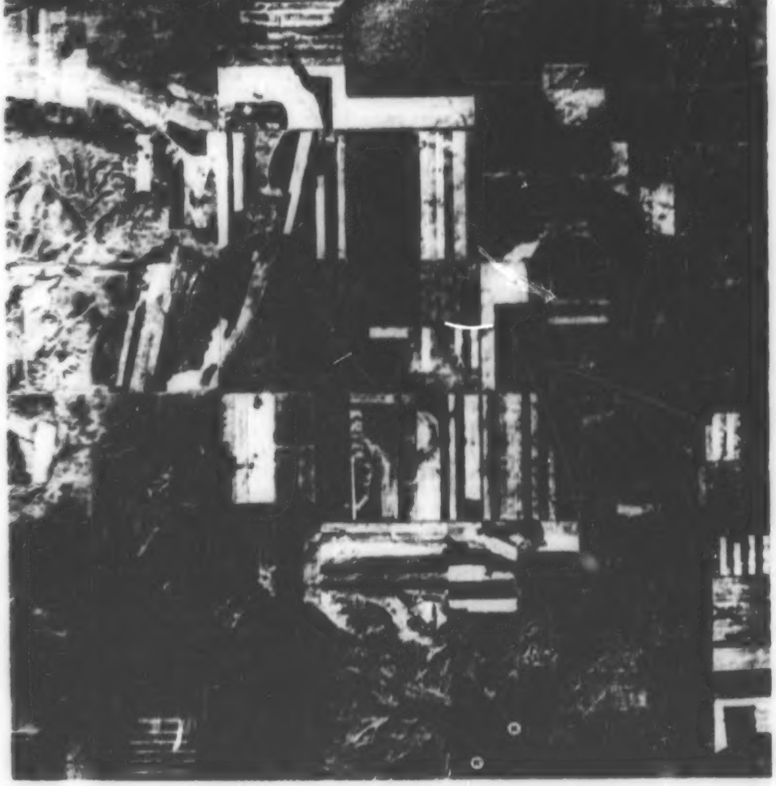


PLATE 28 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
LARSON SCHOOL ORTHOPHOTO QUADRANGLE, MT

PLATE 29 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
KNIFE RIVER MINE ORTHOPHOTO QUADRANGLE, MT

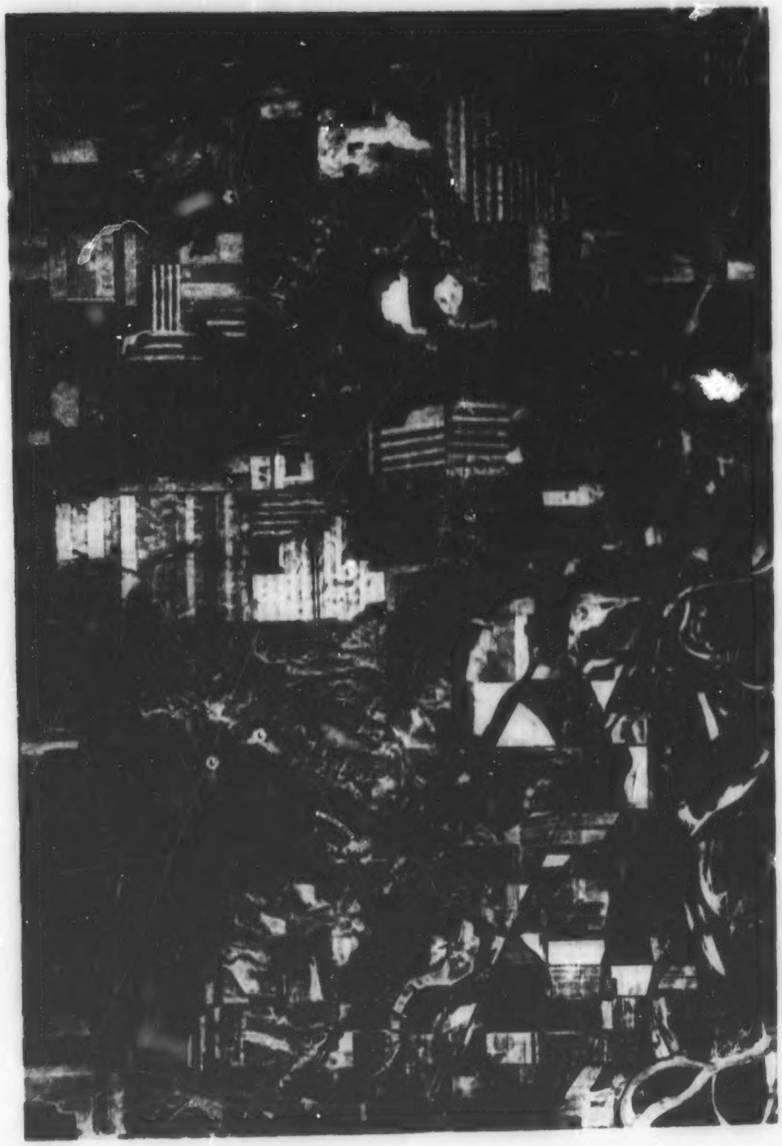
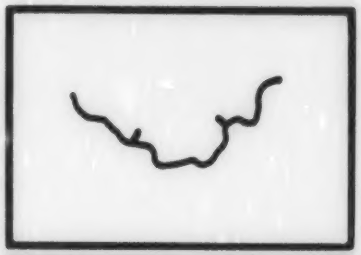


PLATE 30 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
CRANE ORTHOPHOTO QUADRANGLE, MT

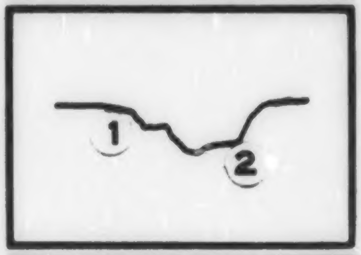
TRANSECTS

Transects A - A' through L - L'   Burns Creek - Thirteenmile Creek KCLA

Legend

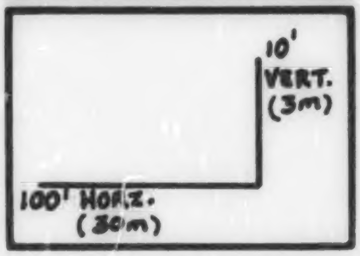


Highest evidence of flood flow (where found) indicated by fiducary marks on either side of channel.

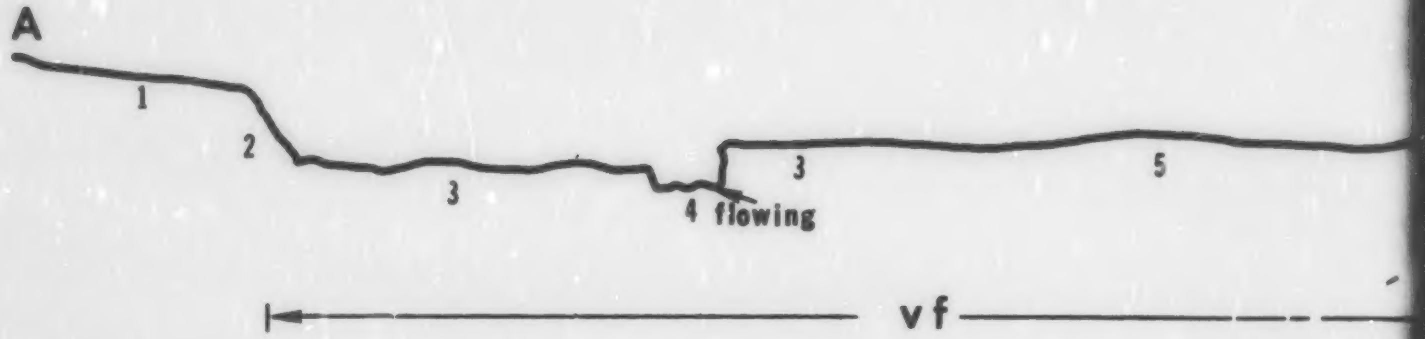


Location of vegetation survey. Observations described below transect in terms of percent of total vegetative cover each species comprises. Descriptions are for a band fifteen meters wide along transect

(transects based on pace and compass measurements, not surveys)



Scale



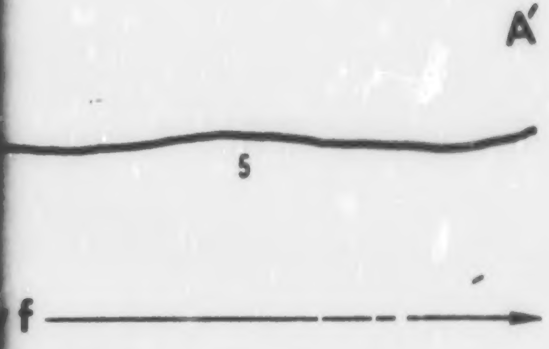
1	yellow sweetclover	50%
	western wheatgrass	20%
	blue grama	T
	western yarrow	T

2	yellow sweetclover	50%
	western wheatgrass	20%
	blue grama	T
	western yarrow	T
	canada wildrye	T

3	yellow sweetclover	30%
	big bluestem	20%
	buffaloberry woods rose	15%
	little bluestem	10%
	prairie sand reedgrass	5%
	western wheatgrass	5%
	fringed sagewort	5%
	switch panicgrass	5%

4	reed canarygrass	50%
	Kentucky bluegrass	10%
	rushes	
	willow	40%

5 yellow sweetclover
fringed sagewort
blue grama
cordgrass
western wheatgrass
creeping juniper



Location shown on

Plate 25, Intake NW

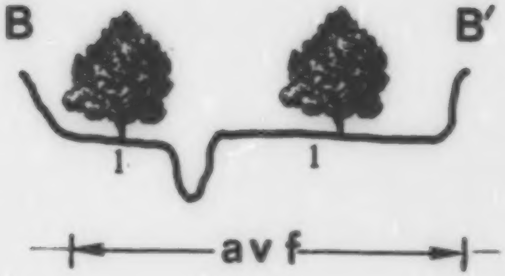
5	yellow sweetclover	40%
	fringed sagewort	30%
	blue grama	10%
	cordgrass	5%
	western wheatgrass	T
	creeping juniper	swards

FIGURE 18

SOUTH FORK BURNS CREEK

Location shown

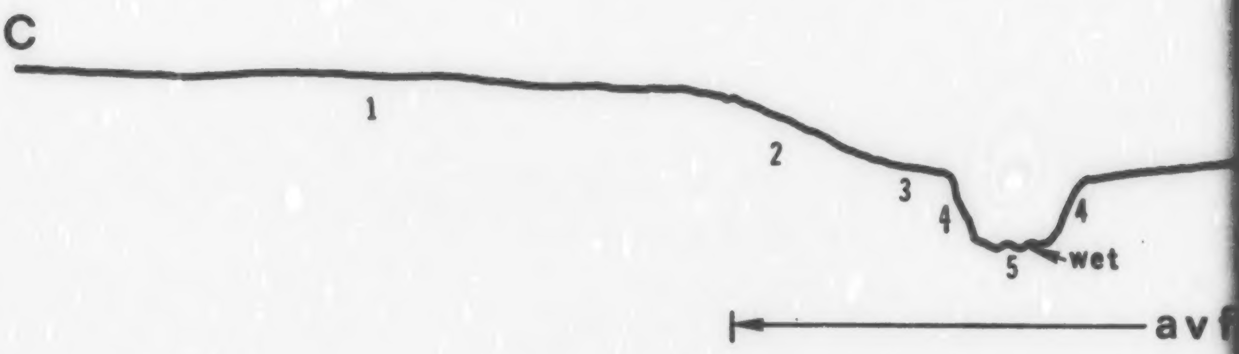
Plate 27, Allard



1	Kentucky bluegrass	80%
	slender wheatgrass	10%
	snowberry	10%
	goosefoot	swards
	western Yarrow	T
	mustard	T
	quackgrass	T

Location shown on
Plate 27, Allard Ranch

FIGURE 19
MIDDLE FORK BURNS CREEK



1	broom snakeweed	cultivated
	crested wheatgrass	
	fescue	

2	western wheatgrass	50%
	broom snakeweed	15-20%
	blue grama	15%
	little bluestem	10%
	slender wheatgrass	5%
	quackgrass	5%
	prairie cordgrass	T

3	western wheatgrass	50%
	Kentucky bluegrass	30%
	common snowberry	5%
	yellow sweetclover	5%
	woods rose buffaloberry	5%
	fringed sagewort	T

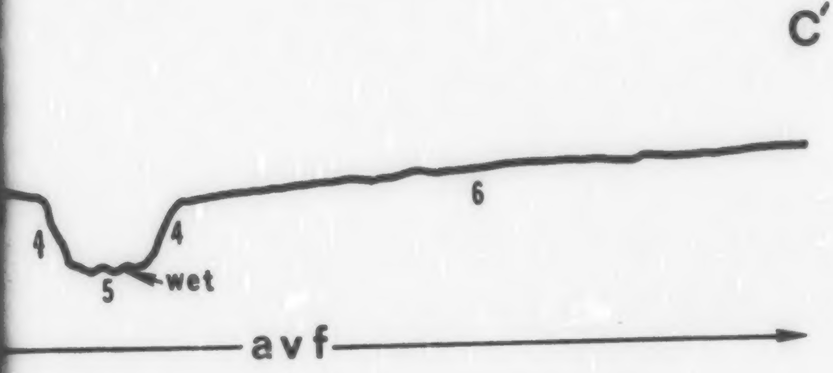
4	slender wheatgrass	40%
	woods rose buffaloberry	40%
	common snowberry	10%
	switch panicgrass	3%
	cordgrass	T
	squirreltail	T

5	baltic rush	100%

6	slender wheatgrass	60%
	Kentucky bluegrass	30%
	western wheatgrass	T

Location shown on

Plate 26, McCone Heights



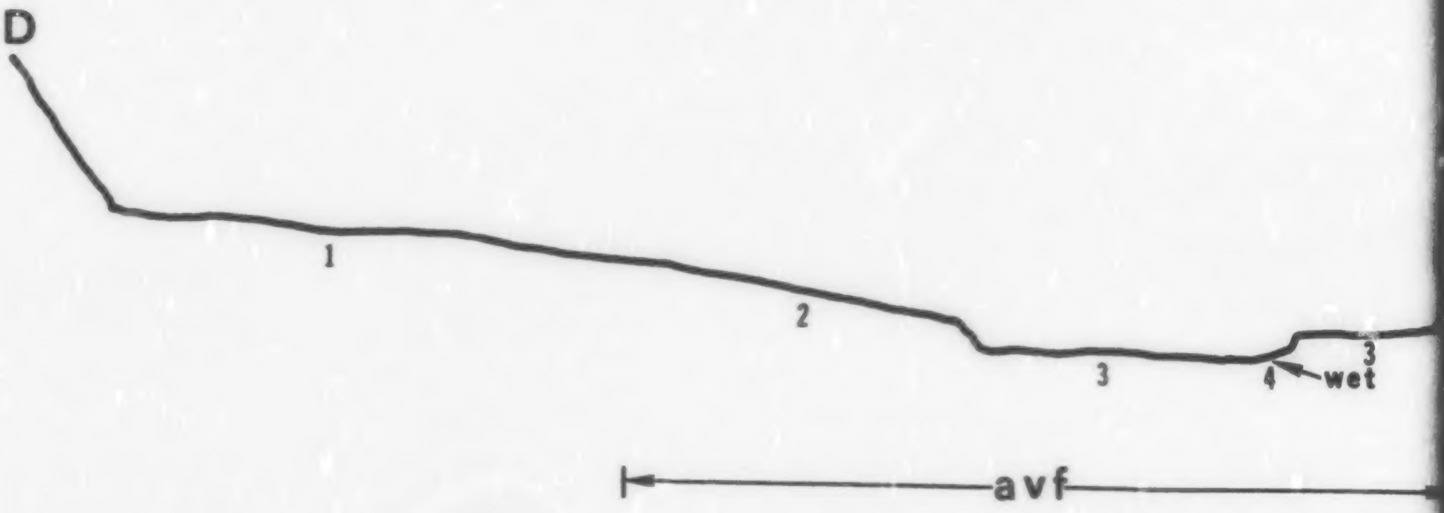
C′
6
4
4
5
wet
avf

s 40%
40%
10%
3%
T
T

100%

s 60%
s 30%
s T

FIGURE 20
NORTH FORK BURNS CREEK



1	common sixweeksgrass	80%
	needle-and-thread	5%
	junegrass	T
	blue grama	T

2	horsetail	15-20%
	fringed sagewort	15%
	little bluestem	10%
	prairie sand reedgrass	10%
	junegrass	7-10%
	yellow sweetclover	5%
	blue grama	T
	Kentucky bluegrass	T
	western wheatgrass	T
	slender wheatgrass	T

3	baltic rush	80%
	switch panicgrass	5%
	woods rose buffaloberry	5%
	common snowberry	T
	slender wheatgrass	T
	reed canarygrass	T

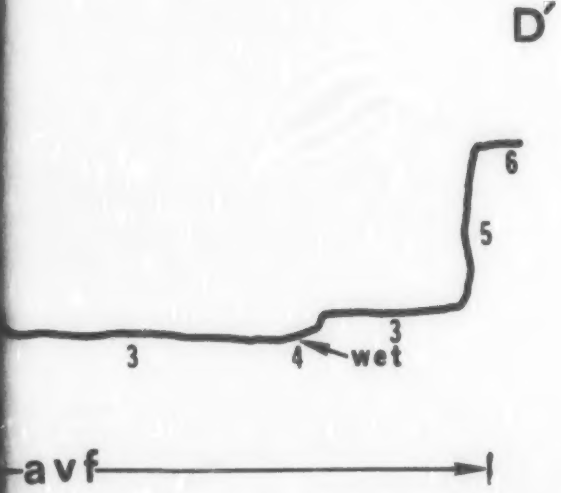
4 no vegetation

5 Kentucky bluegr
slender wheatgr
common snowberr
woods rose
buffaloberry

6 Kentucky bluegr
blue grama
western wheatgr
needle-and-thre
fringed sagewort

Location shown on

Plate 24, Butler Table

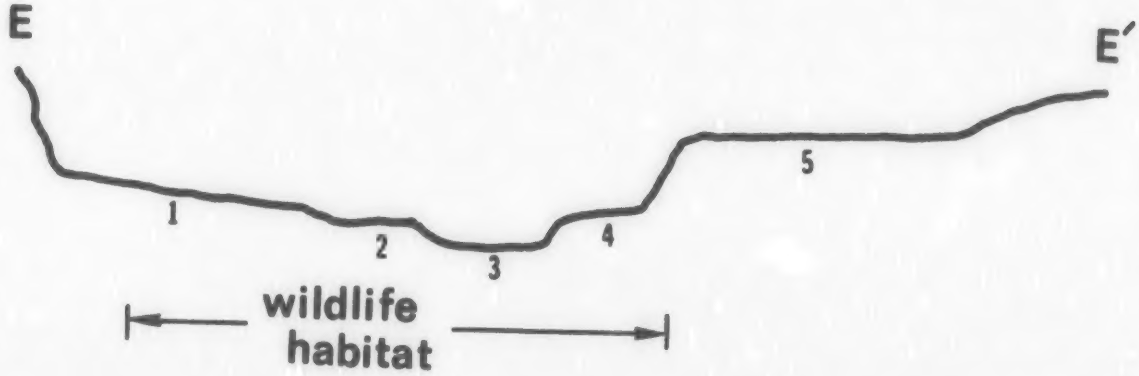


5		
	Kentucky bluegrass	60%
	slender wheatgrass	30%
	common snowberry	10%
	woods rose	T
	buffaloberry	T

6		
	Kentucky bluegrass	60%
	blue grama	10%
	western wheatgrass needle-and-thread fringed sagewort	30%

FIGURE 21

NORTH FORK BURNS CREEK



Loc

Plate

1	Kentucky bluegrass	80%
	common snowberry	15%
	silver sagebrush	5%
	buffaloberry woods rose	5%

2	common sixweeksgrass	30%
	Kentucky bluegrass	30%
	slender wheatgrass	15%
	baltic rush	10%
	common snowberry	5%
	fringed sagewort	T
	squirreltail	T

3	baltic rush	80%

4 common snowberry
woods rose
Kentucky bluegra
slender wheatgra
fringed sagewort

5 needle-and-threa
silver sagebrush
fringed sagewort
slender wheatgra
blue grama

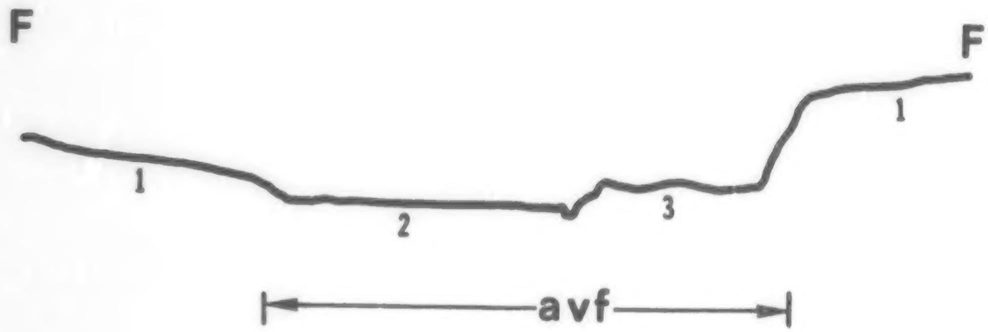
E′

Location shown on
Plate 24, Butler Table

4	common snowberry woods rose	35%
	Kentucky bluegrass	30%
	slender wheatgrass	20%
	fringed sagewort	T
5	needle-and-thread	35%
	silver sagebrush	20%
	fringed sagewort	5%
	slender wheatgrass	5%
	blue grama	T

FIGURE 22
NORTH FORK BURNS CREEK

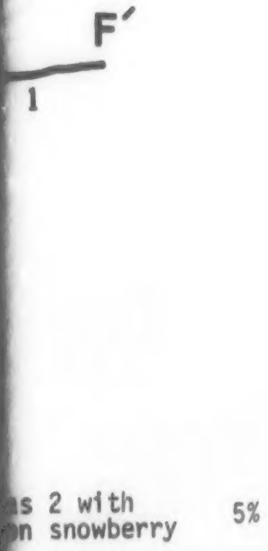
Locatio
Plate 2



1 wheat

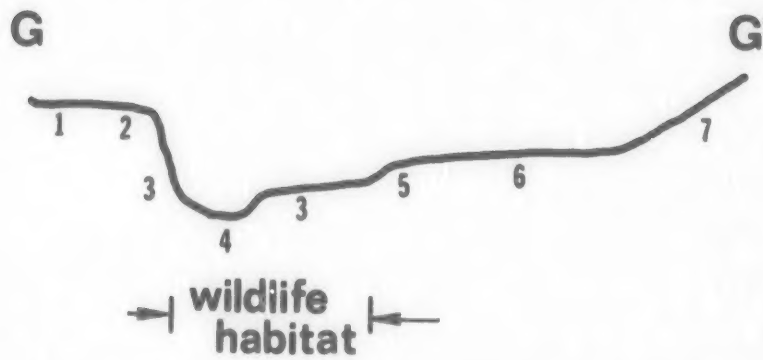
2 woods rose	30%
Kentucky bluegrass	25%
fescue	8-10%
big bluestem	5%
Canada wildrye	5%
common snowberry	T
sunflower	T
silver sagebrush	T
crested wheatgrass	T
slender wheatgrass	T

3 same as 2 with common snowberry	5%


F′
1
s 2 with
n snowberry
5%

Location shown on
Plate 22, Enid SE

FIGURE 23
MIDDLE FORK BURNS CREEK



Location shown on

Plate 20, Clay Butte

1 wheat

2	
broom snakeweed	30%
prairie sand reedgrass	25%
yellow sweetclover	20%
little bluestem	20%
buffaloberry	T
wild licorice	T

3	
woods rose buffaloberry	90%
Kentucky bluegrass	T
smooth brome	T

4	
sedges	80%
reeds	10%
foxtail barley	T

5	
Kentucky bluegrass	70%
prairie sand reedgrass	20%
buffaloberry	5-10%
thimothy	T
thistle	T
goosefoot	T
slender wheatgrass	T

Location shown on
Plate 20, Clay Butte

	80%
	10%
	T

ss	70%
grass	20%
	5-10%
	T
	T
	T
ss	T

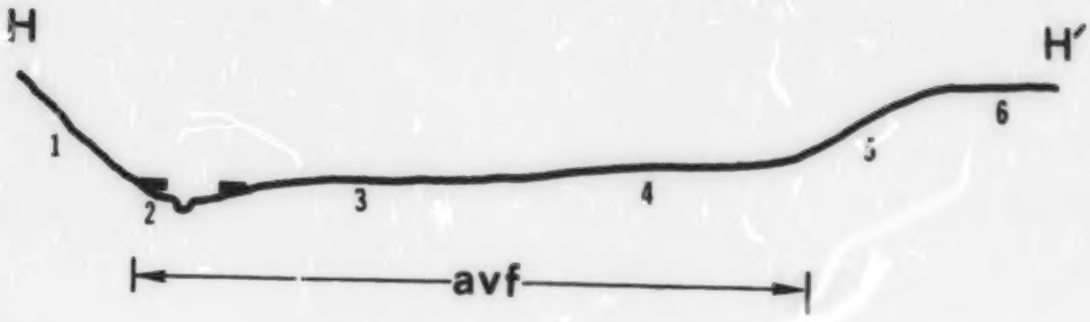
6	Kentucky bluegrass	25%
	prairie sand reedgrass	20%
	horsetail	20%
	yellow sweetclover	15%
	slender wheatgrass	15%
	little bluestem	5%
	thistle	T
	thimothy	T
	fringed sagewort	T
	goosefoot	T

7	prairie sand reedgrass	50%
	blue grama	30%
	Kentucky bluegrass	15%
	broom snakeweed	5%
	junegrass	3-4%

FIGURE 24
NORTH FORK
THIRTEENMILE CREEK

Locati

Plate 20



1	prairie sand reedgrass	40%
	yellow sweetclover	25%
	little bluestem	20%
	alkali sacaton	10%
	forbs	T
	horsetail	T
	junegrass	T
	woods rose	T

2	rush	90%

3	switch panicgrass	25%
	dropseed	25%
	forbs	25%
	slender wheatgrass	20%
	little bluestem	5%

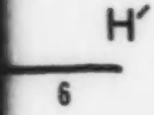
4	slender wheatgrass	50%
	switch panicgrass	20%
	dropseed	5%
	common snowberry	swards
	forbs	T

5	prairie sand	
	hairy golden	
	little bluest	
	juniper	

6	wheat	

Location shown on

Plate 20, Clay Butte



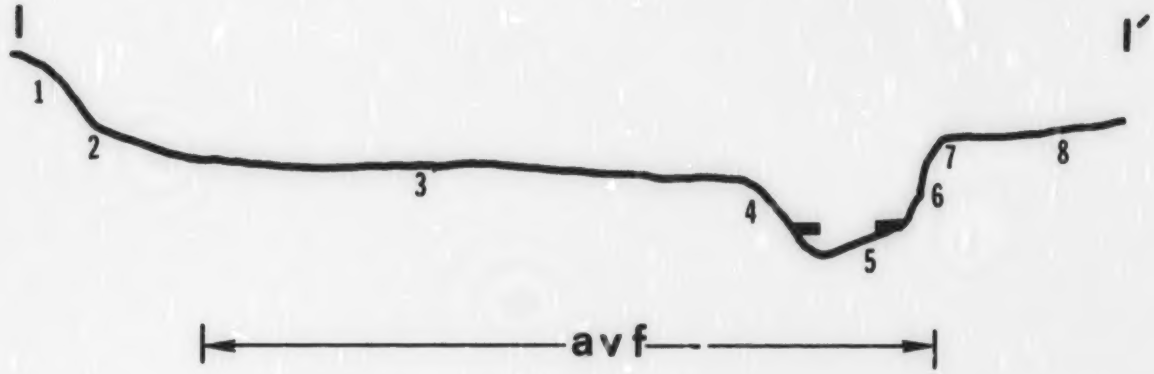
25%
25%
25%
20%
5%

5	prairie sand reedgrass	60%
	hairy golden aster	15%
	little bluestem	12-15%
	juniper	T

6 wheat

50%
20%
5%
rds
T

FIGURE 25
NORTH FORK
THIRTEENMILE CREEK



1	blue gramma	90%
	broom snakeweed	5%
	fringed sagewort	T

2	western wheatgrass	95%
	broom snakeweed	5%

3	sandberg bluegrass	40%
	western wheatgrass	40%
	little bluestem	3%
	switch panicgrass	T
	common snowberry	T
	curlycup gumweed	T

4	American sloughgrass	60%
	sedges	10%
	Canada wildrye	T
	little bluestem	T
	woods rose	T

5	American sloughgrass	50%
	curly dock	40%

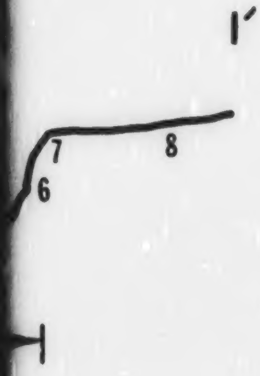
6	woods rose	90%
	common snowberry	

6 little blues
canada wildr
western whea

7 western whea
blue grama
broom snakew
wild licoric

8 wheat

Location shown on
Plate 22, Enid SE



60%
10%
T
T
T

50%
40%

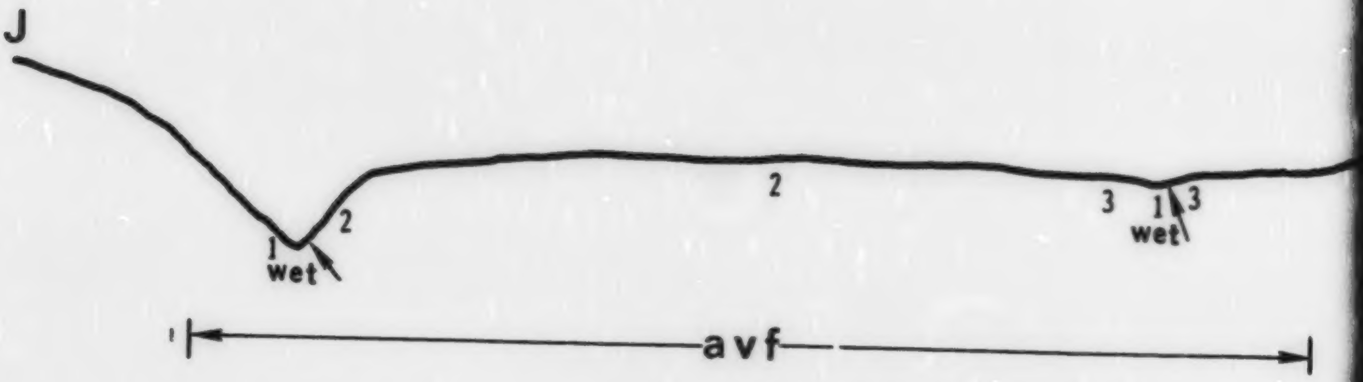
90%

6	little bluestem	T
	canada wildrye	T
	western wheatgrass	T

7	western wheatgrass	80%
	blue grama	15%
	broom snakeweed	T
	wild licorice	T

8 wheat

FIGURE 26
SOUTH FORK BURNS CREEK

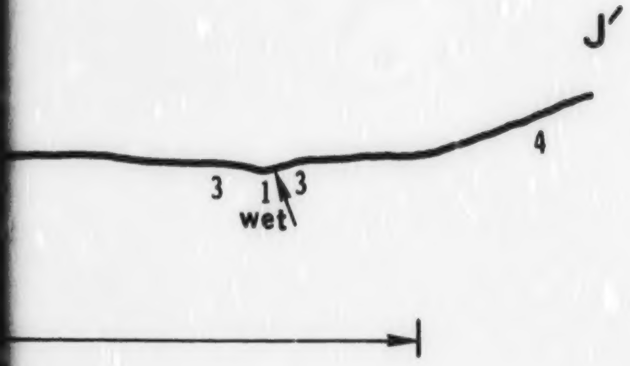


1	prairie cordgrass	

2	slender wheatgrass	80%
	switch panicgrass	10%
	hairy golden aster	5%
	prairie cordgrass	T
	woods rose	T
	common snowberry	T

3	rush	95%
	Kentucky bluegrass	T
	reed canarygrass	T
	hairy golden aster	T

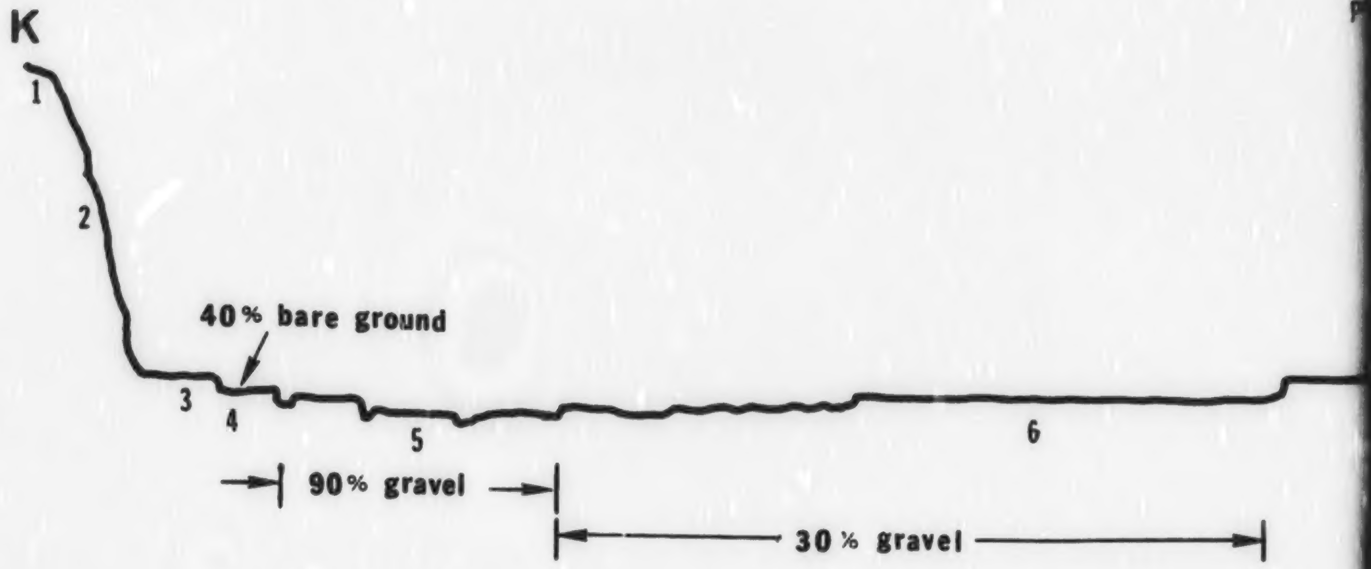
4	blue grama	60%
	western wheatgrass	30%
	slender wheatgrass	T
	curlycup gumweed	T



Location shown on
Plate 28, Larson School

FIGURE 27
CRANE CREEK

Lo
p



1	blue grama	95%
	sideoats grama	5%
	sandberg bluegrass	5%
	broom snakeweed	5%
	western wheatgrass	5%

2	blue grama	50%
	prairie sand reedgrass	10-15%
	sideoats grama	10%
	little bluestem	5%
	red threeawn	2-3%
	brome snakeweed	T
	yucca	T
	curlycup gumweed	T
	western wheatgrass	T
	needle-and-thread	T

3	blue grama	90%
	western wheatgrass	5%
	cudweed sagewort	T
	fringed sagewort	T

4	blue grama	50%
	cudweed sagewort	45%
	needle-and-thread	4-5%
	woods rose	T

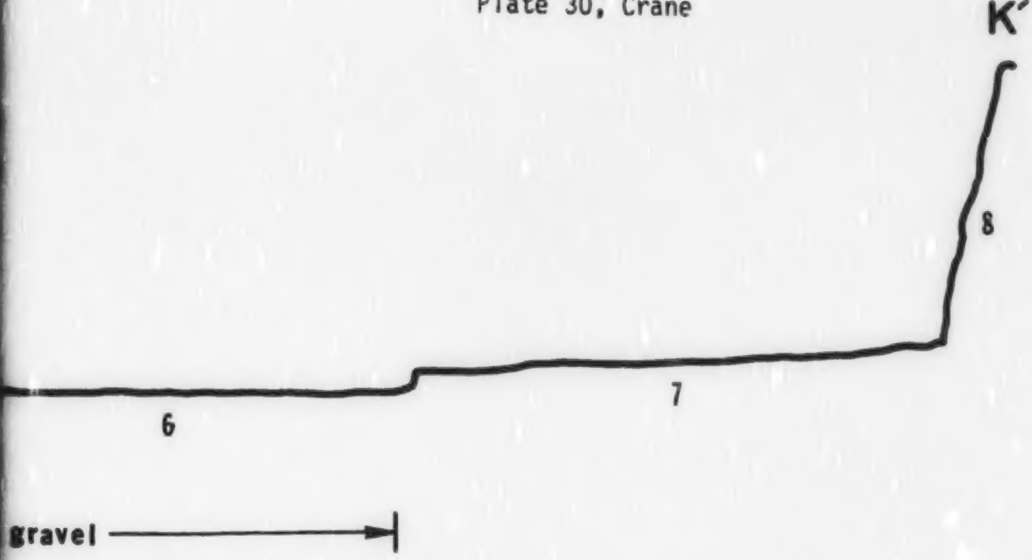
5 needle-and-thread
hairy golden aster
woods rose

6	blue grama	50%
	fringed sagewort	50%
	prairie sand reedgrass	swards
	woods rose	swards

7 wes
blu
nee
lit
woo
pla
clu
red

8 lit
blu
sid
pra
woo
bro

Location shown on
Plate 30, Crane



	90%
eatgrass	5%
gewort	T
gewort	T

	50%
gewort	45%
-thread	4-5%
	T

-thread
len aster

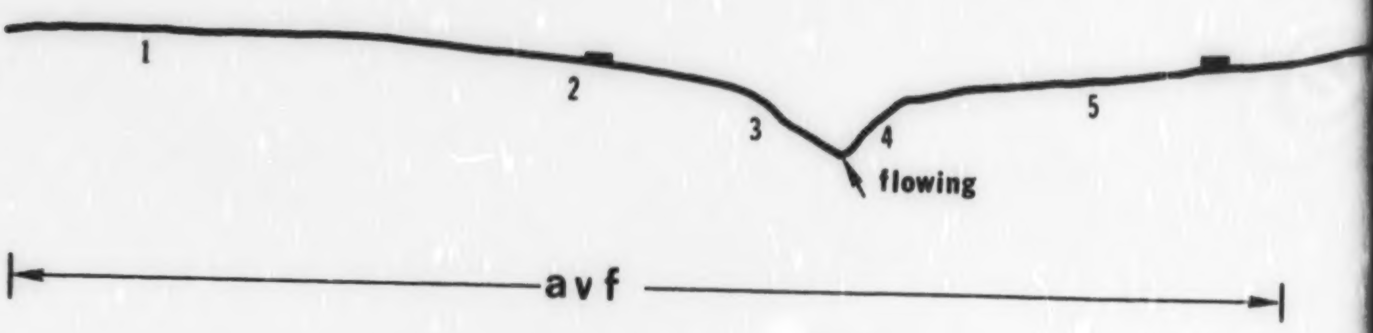
	50%
gewort	50%
nd reedgrass	swards
	swards

7	western wheatgrass	60%
	blue grama	30%
	needle-and-thread	10%
	little bluestem	T
	woods rose	T
	plains prickly pear	T
	club moss	T
	red threeawn	T

8	little bluestem	50%
	blue grama	45%
	sideoats grama	T
	prairie sand reedgrass	T
	woods rose	T
	broom snakeweed	T

FIGURE 28
DUNLAP CREEK

L



1	western wheatgrass	30%
	blue grama	25%
	prairie sand reedgrass	25%
	fringed sagewort	4%
	hairy golden aster	T
	horsetail	T
	prairie cordgrass	T
	woods rose	T

2	dropseed	50%
	switch panicgrass	30%
	prairie cordgrass	5%
	slender wheatgrass	5%
	blue grama	5%
	curlycup gumweed	2-3%

3	yellow sweetclover	40%
	horsetail	25%
	canada wildrye	5%
	rose	T
	prairie cordgrass	T
	wild licorice	T
	curlycup gumweed	T
	fringed sagewort	T
	squirreltail	T

4	western wheatgrass	30%
	Canada wildrye	20%
	green bristlegrass	T
	prairie cordgrass	T
	buffaloberry	T
	forbs	T

5	blue grama	45%
	little bluestem	25%
	prairie sand reedgrass	5%
	horsetail	2-3%
	yellow sweetclover	T
	Canada wildrye	T
	western wheatgrass	T
	fringed sagewort	T
	pussytoes	T
	buffaloberry	T
	switch panicgrass	T

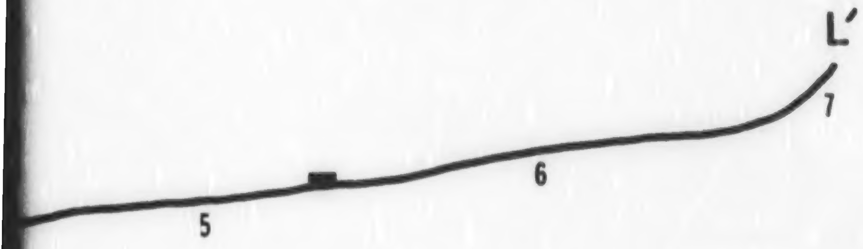
5 Other area
dropseed
switchgras
buffalober
slender wh
little blu
prairie co

6 blue grama
western wh
prairie sa
horsetail
fringed sa
woods rose

7 blue grama
western wh

Location shown on

Plate 30, Crane



wing

30%
20%
T
T
T
T

45%
25%
ass 5%
2-3%
T
T
T
T
T
T
T

5	Other areas, same terrace	
	dropseed	45%
	switchgrass	30%
	buffaloberry	20%
	slender wheatgrass	10%
	little bluestem	swards
	prairie cordgrass	T
6	blue grama	60%
	western wheatgrass	30%
	prairie sand reedgrass	5%
	horsetail	T
	fringed sagewort	T
	woods rose	T
7	blue grama	60%
	western wheatgrass	40%

FIGURE 29
SEARS CREEK

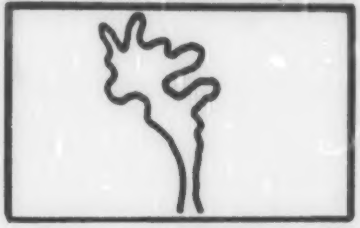
APPENDIX II

Area 2. Weldon - Timber Creek Deposit

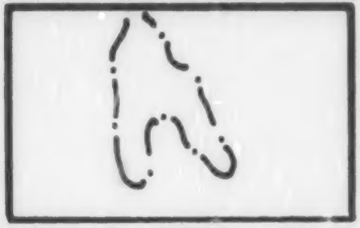
LEGEND

1:76,000 aerial photographs
(Plates 1-8)

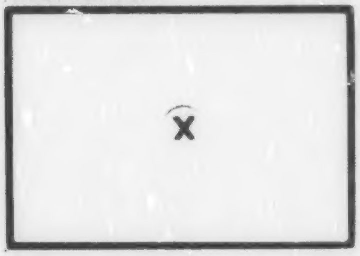
Weldon-Timber Creek Deposit



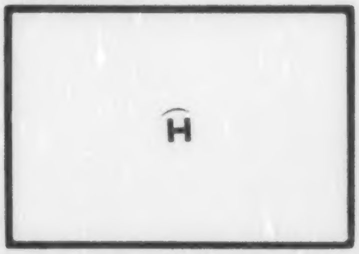
Alluvial Valley Floors. These are mapped as the low terrace, floodplain, and channel of major drainages and those minor drainages whose low terraces are either used in part for hay production or which have the potential for such use. These areas may include soils which have potential salinity problems. Areas less than 15 m wide are excluded (see text).



Strippable Coal Deposits (Matson, 1970). Denotes area of the "S" coal seam under less than 46 m of overburden.



Nominated BLM Lands for Coal Leasing (BLM, 1976). Lands nominated in 1976 for leasing by Bureau of Land Management for coal development; shown only beyond the limits of indicated strippable coal (Matson, 1970) to suggest additional area of coal resource.



Hayed Lands. Lands where hay was observed to be harvested, and lands irrigated for that purpose. Irrigated lands mapped by the Montana Water Resources Board (1971b) and lands appraised as wild hay land under the Montana Agricultural Land Classification.

Location of Saline Soils. Where valley soils were mapped as "typic fluvaquents, 0-2% slopes, saline. Tend to have surface and subsurface gypsum crystals", or be the Alona series soils which have a moderately alkaline surface, moderately to strongly alkaline subsoils, and strongly alkaline parent material. (Strom, in progress) Includes observed salt crusts where soil survey data unavailable.

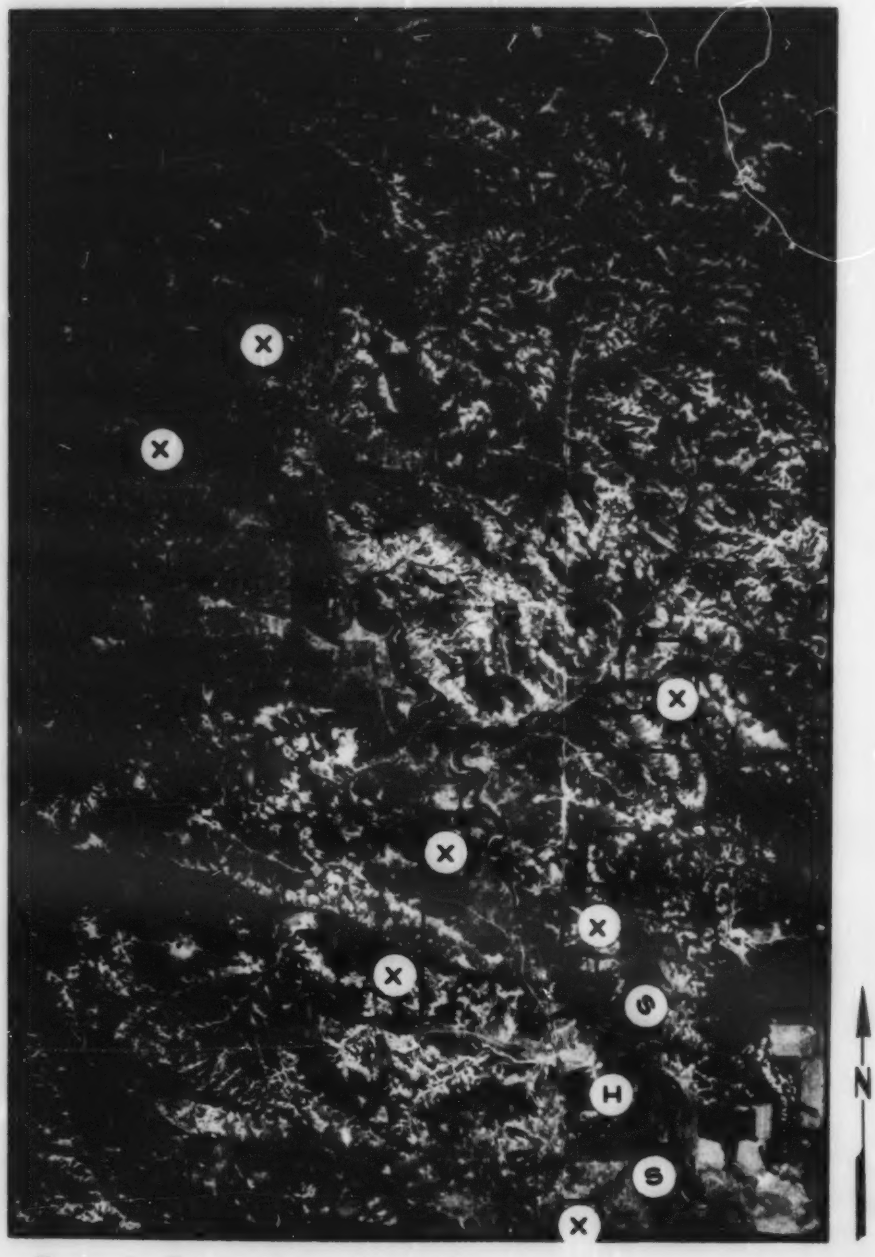

X
X
X
X
X
X
S
H
S
X
N

PLATE 1 TIMBER CREEK (AREA 2)

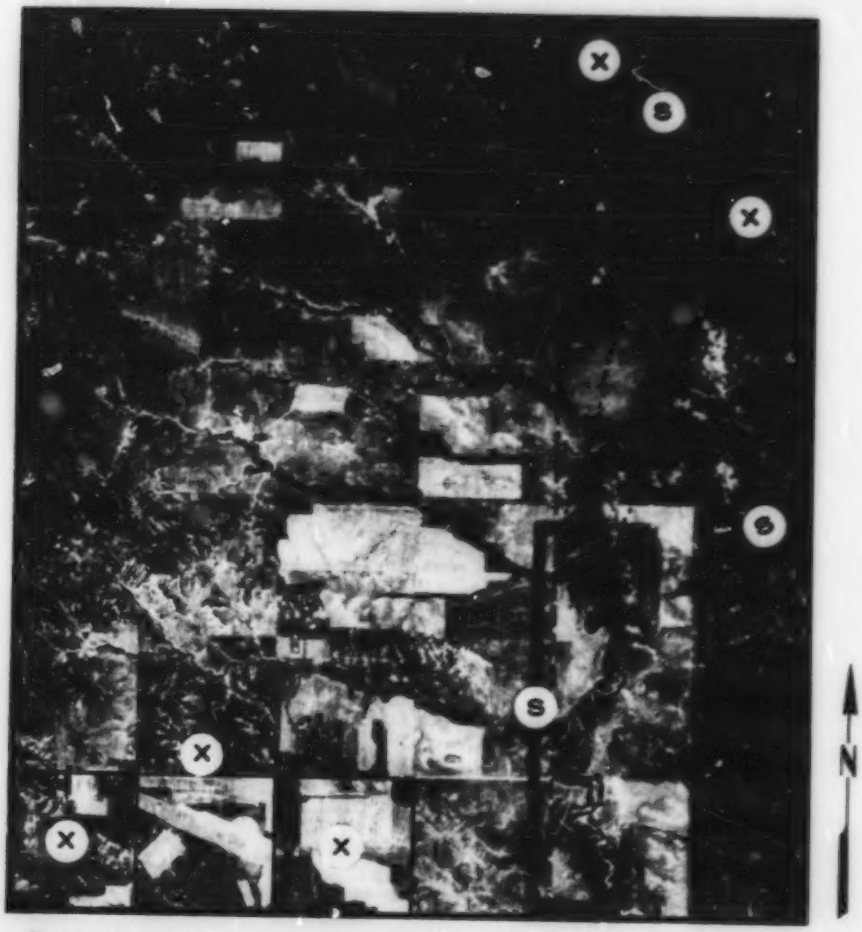


PLATE 2 SKULL AND TIMBER CREEKS (AREA 2)

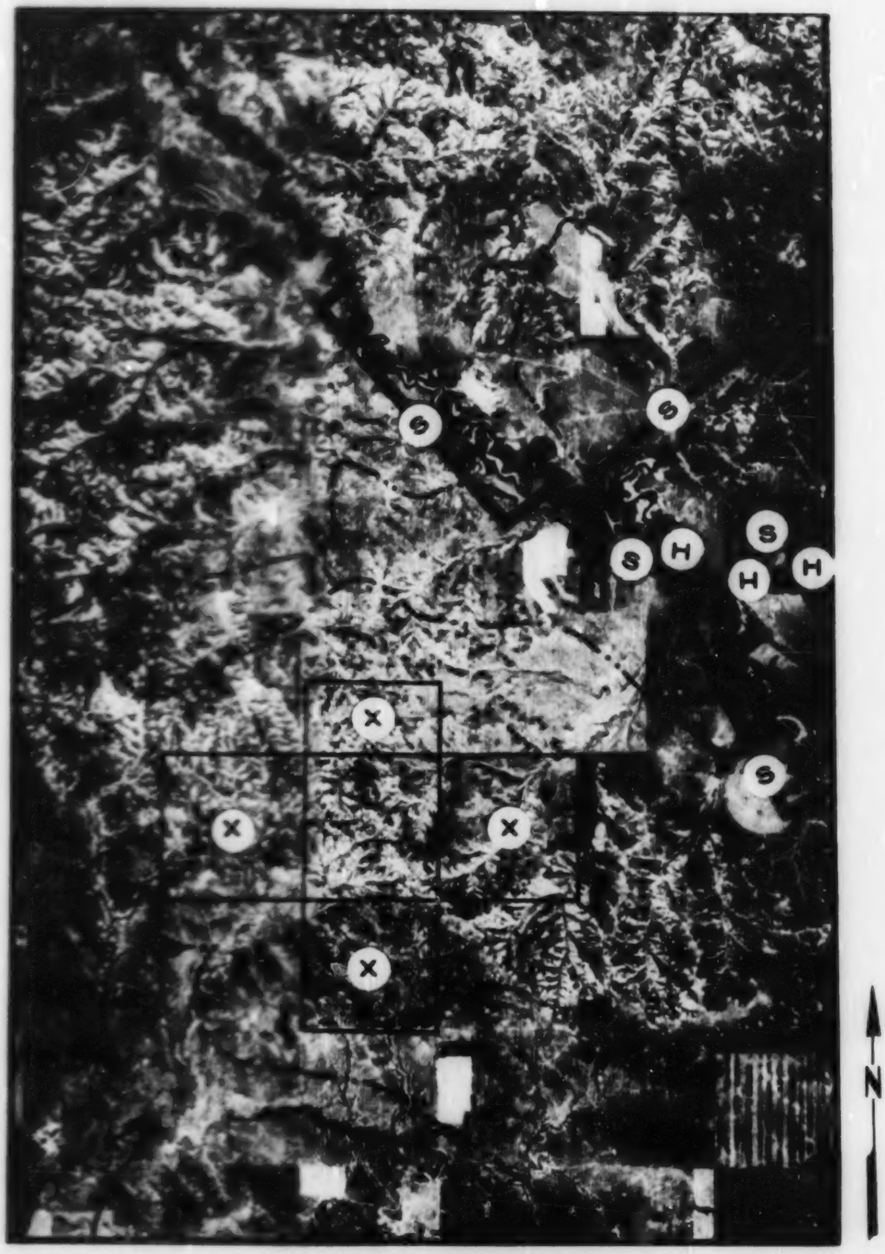

S
S
S
H
S
H
H
X
X
X
X
S
N

PLATE 3 NELSON CREEK WEST (AREA 2)

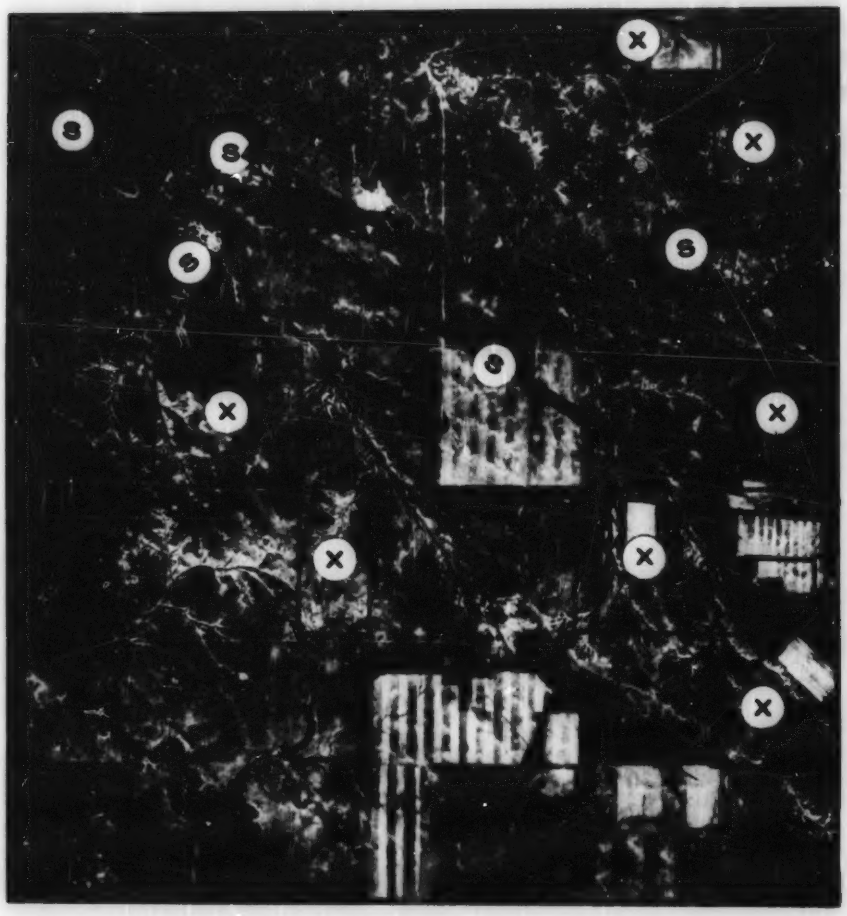

S
S
S
S
S
X
X
X
X
X
X
X
X

PLATE 4 SKULL CREEK (AREA 2)

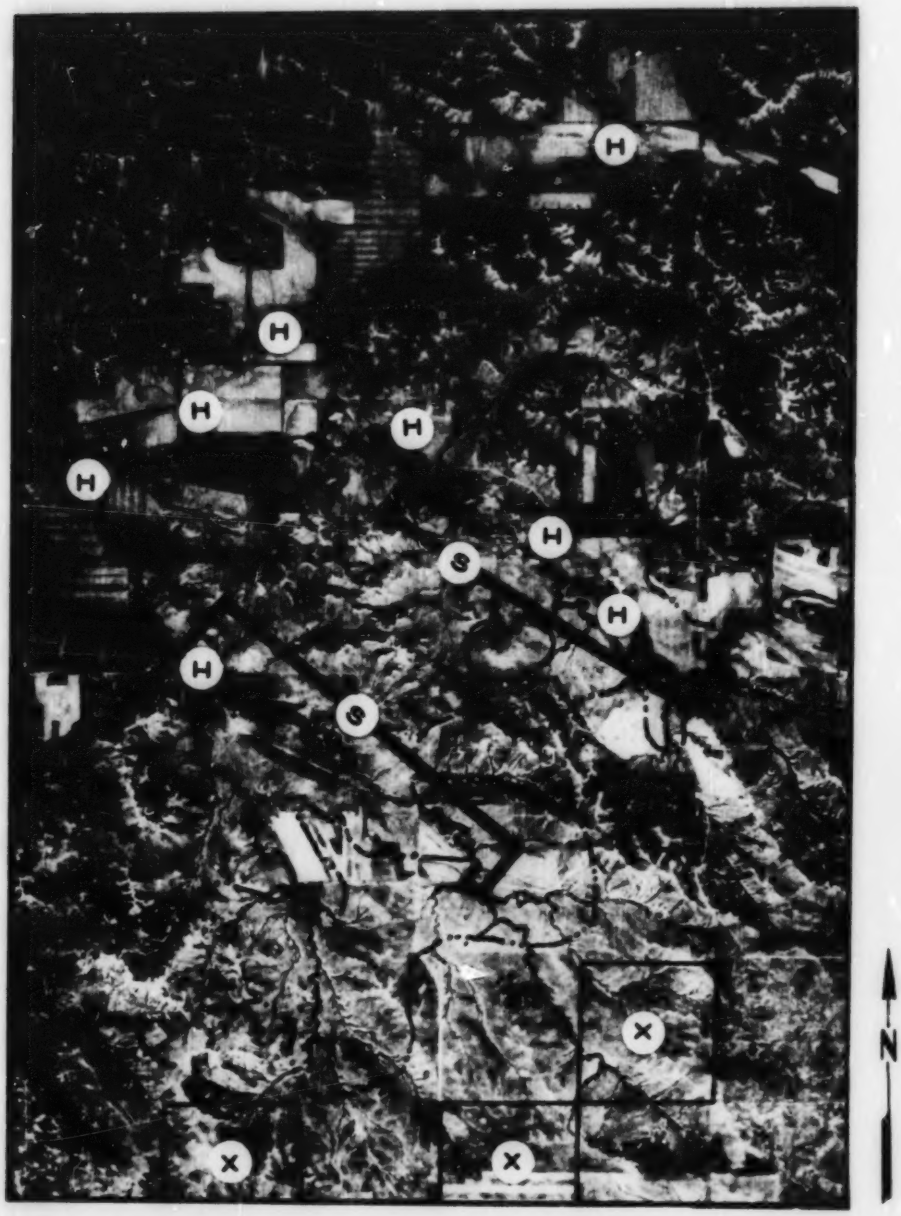

H
H
H
H
H
H
S
H
H
S
X
X
X
N

PLATE 5 McGUIRE CREEK (AREA 2)

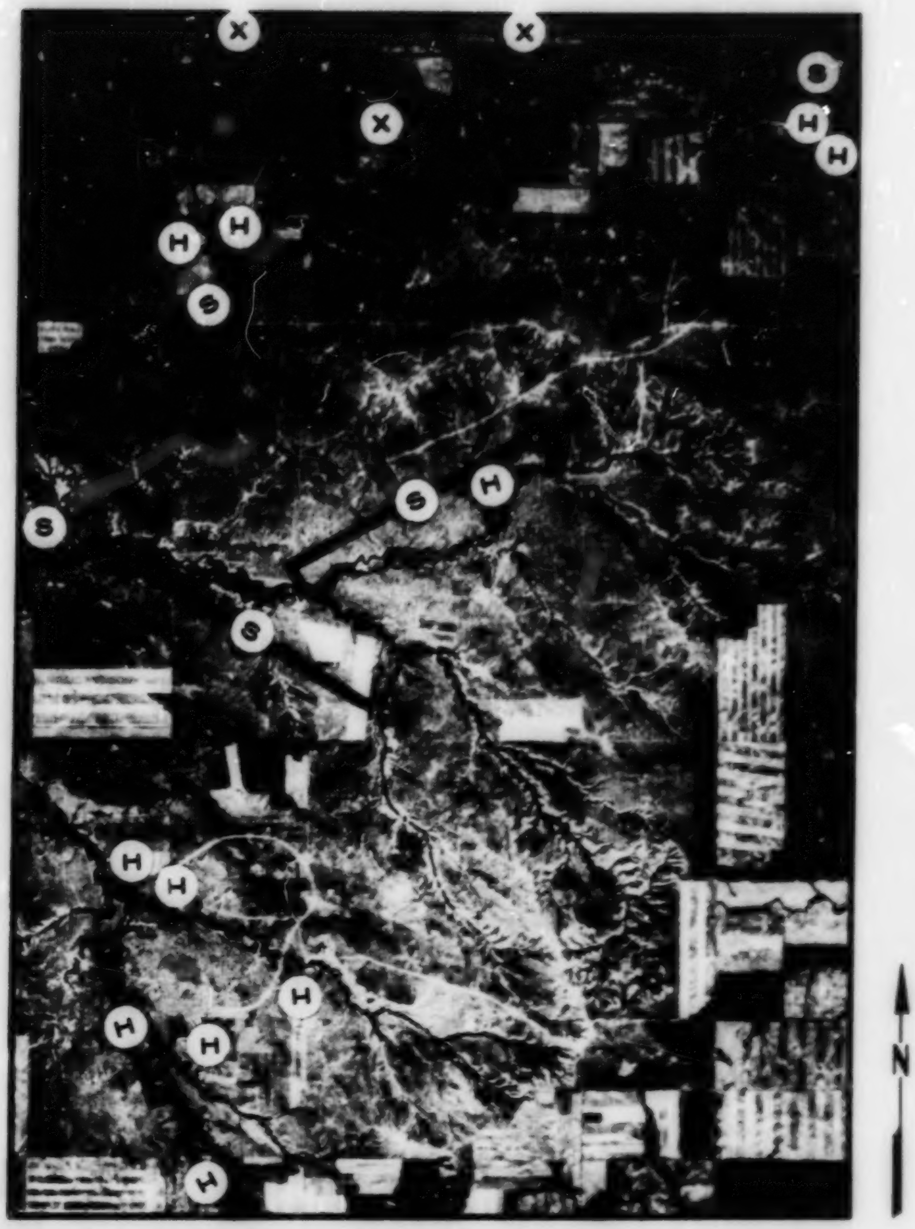

X
X
X
S
H
H
H
H
S
S
S
H
S
H
H
H
H
H
H
N

PLATE 6 NELSON CREEK EAST (AREA 2)

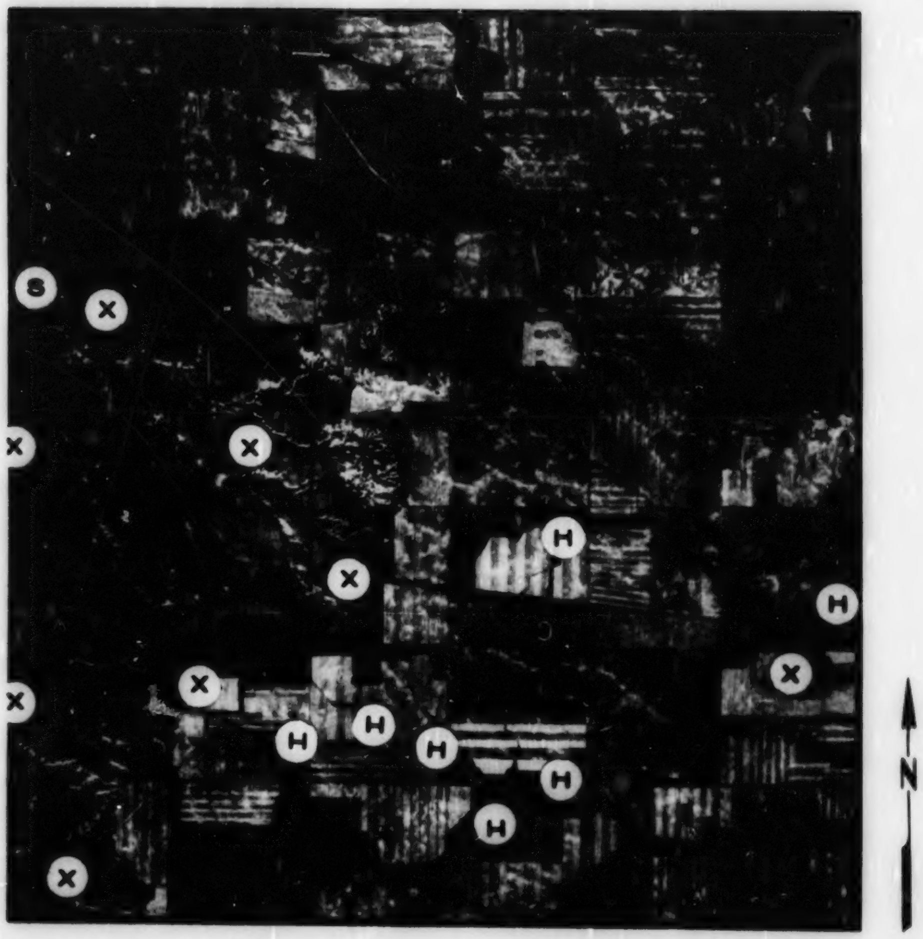

S
X
X
X
H
X
H
X
X
H
H
H
H
H
X
N

PLATE 7 DIRTY CREEK (AREA 2)

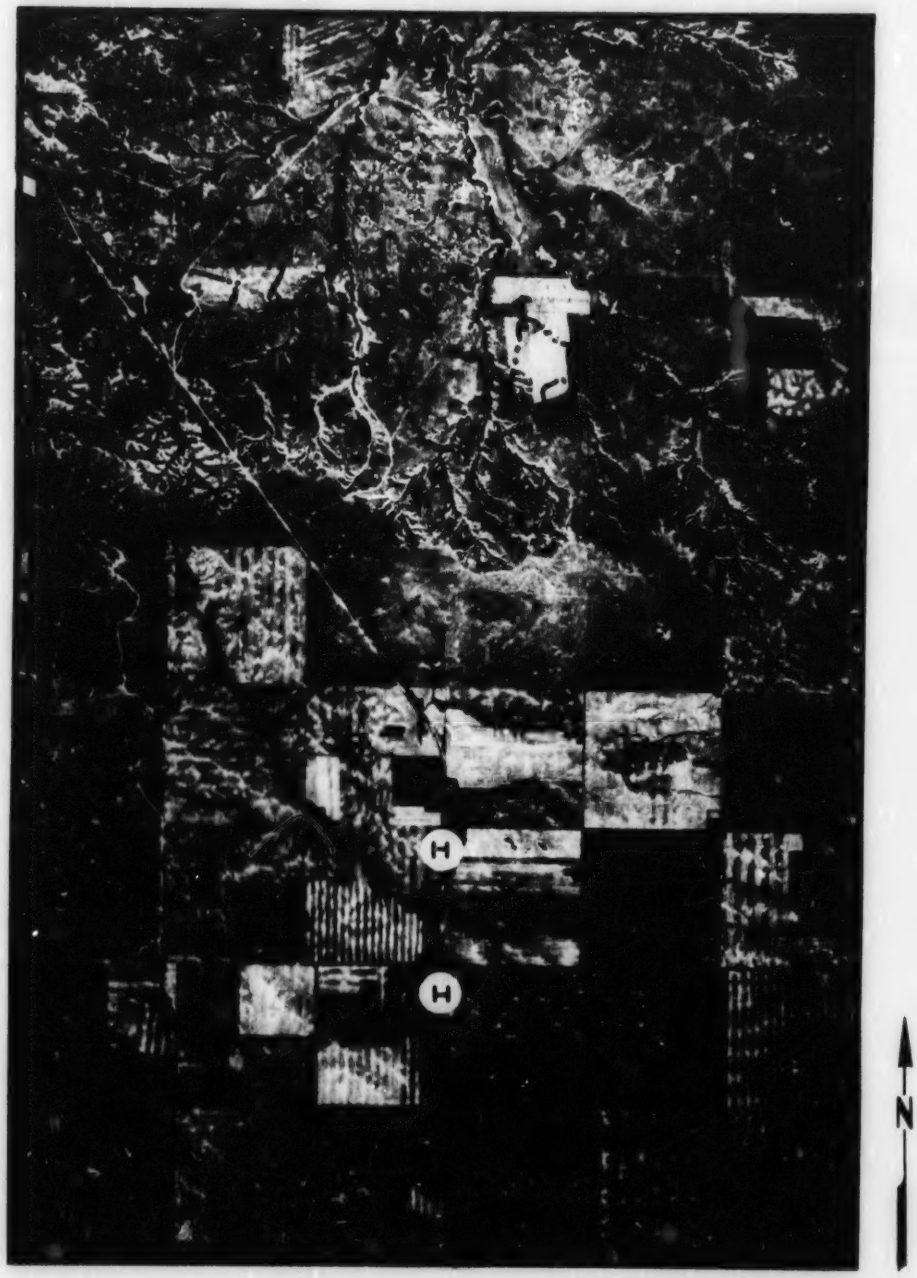


PLATE 8 HORSE AND PRAIRIE ELK CREEK (AREA 2)

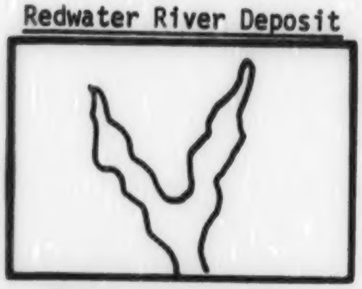
APPENDIX III

Area 3. Redwater River Deposit

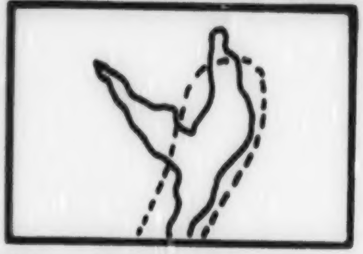
LEGEND

1:76,000 aerial photographs
(Plates 9 - 19)

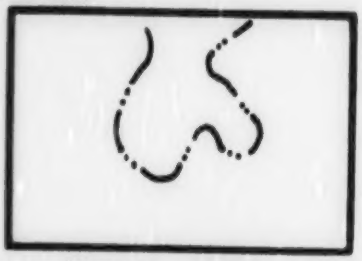
Redwater River Deposit



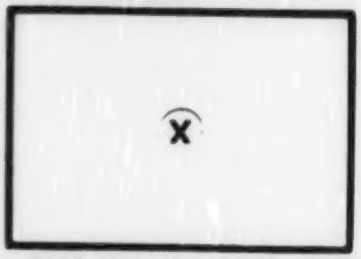
Alluvial Valley Floors. These are mapped as the low terrace, floodplain, and channel of major drainages and those minor drainages whose low terraces are either used in part for hay production or which have the potential for such use. These areas may include soils which have potential salinity problems. Areas less than 15 m wide excluded (see text).



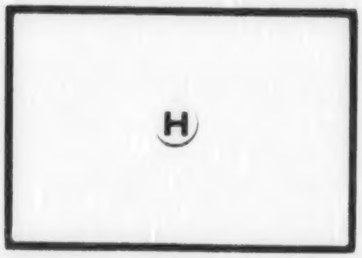
Related Alluvial Deposits. Dashed lines show upper boundaries of higher alluvial deposits along Redwater River. Includes recent (?) alluvial deposits of the Redwater River. Includes surface colluvium probably underlain by alluvium.



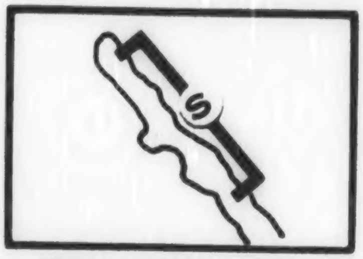
Strippable Coal Deposits (Matson, 1970). Denotes area of the "S" coal seam under less than 46 m of overburden.



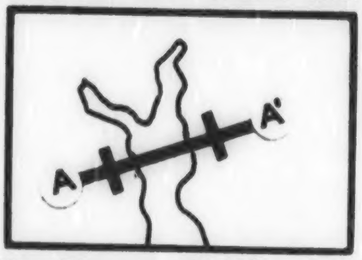
Nominated BLM Lands for Coal Leasing (BLM, 1976). Lands nominated in 1976 for leasing by Bureau of Land Management for coal development; shown only beyond the limits of indicated strippable coal (Matson, 1970) to suggest additional areas of coal resource.



Hayed Lands. Lands where hay was observed to be harvested, and lands irrigated for that purpose. Irrigated lands mapped by the Montana Water Resources Board (1971b) and lands appraised as wild hayland under the Montana Agricultural Land Classification.



Location of Saline Soils. Where valley soils were mapped as "typic fluvaquents, 0-2% slopes, saline. Tend to have surface and subsurface gypsum crystals", or be the Alona series, soils which have a moderately alkaline surface, moderately to strongly alkaline subsoils, and strongly alkaline parent material (Strom, in progress). Includes observed salt crusts where soil survey data unavailable.



Location of Transect. (See Figures 30-33). Fiducial marks indicate terminal points of measurements.

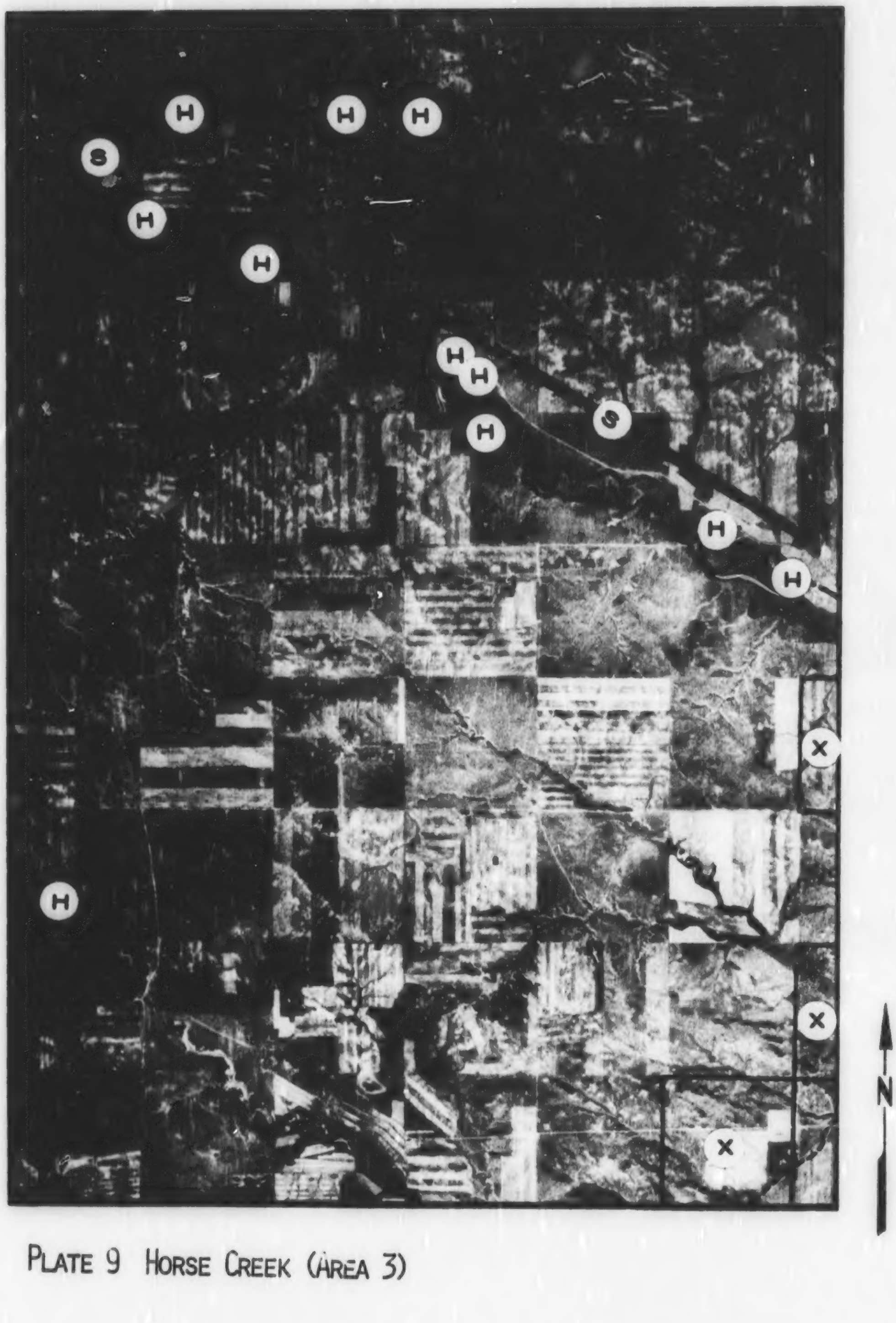

H
H
H
S
H
H
H
H
H
S
H
H
X
H
X
X
N

PLATE 9 HORSE CREEK (AREA 3)

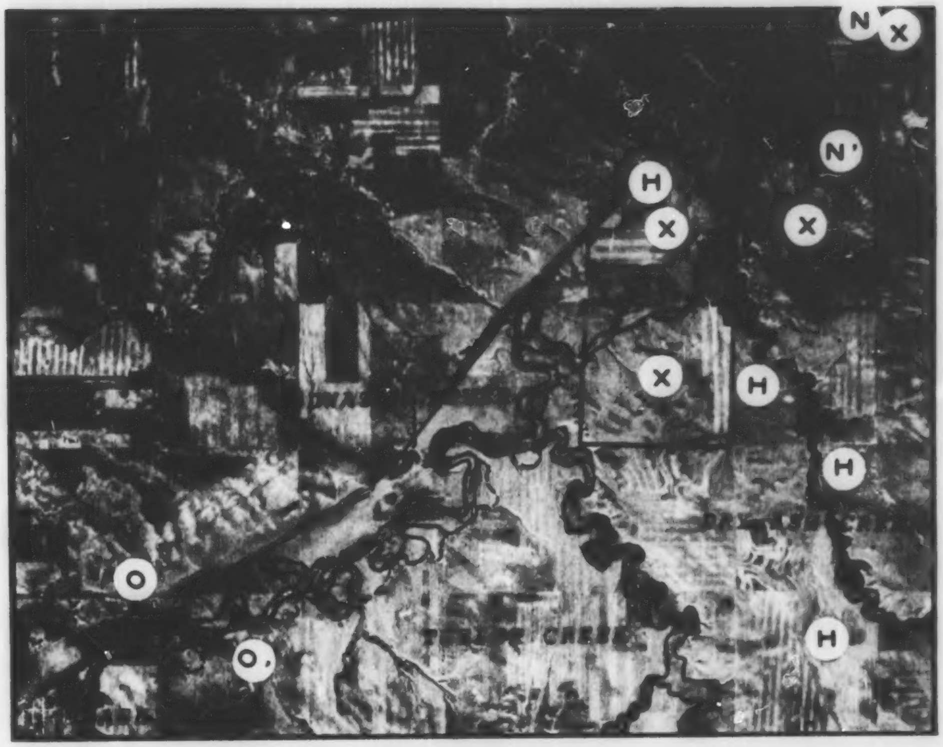

N
X
N'
H
X
X
X
H
H
O
O'
H

PLATE 10 TIMBER AND DRY ASH CREEKS (AREA 3)

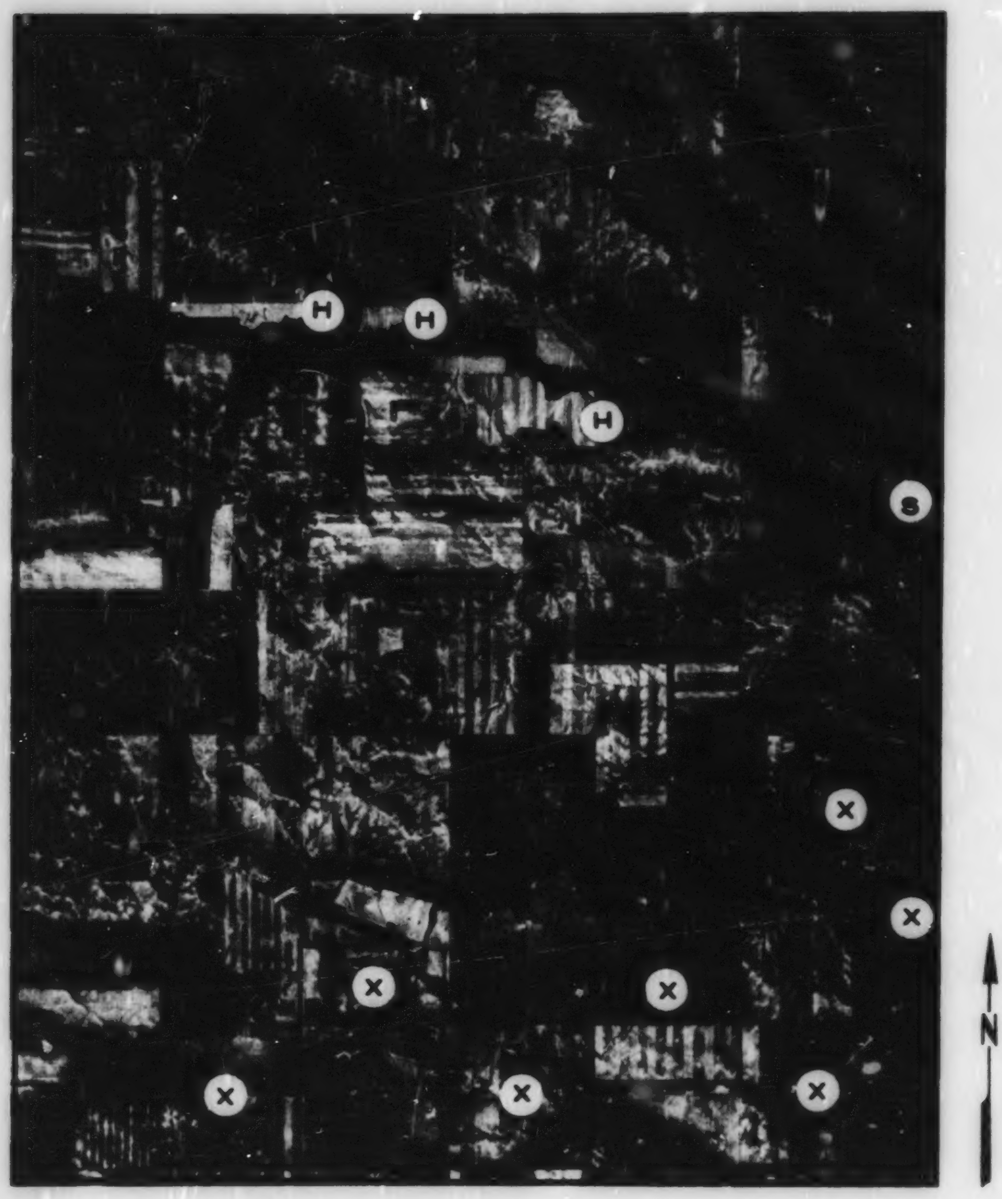

H
H
H
S
X
X
X
X
X
X
X
N

PLATE 11 COW CREEK WEST (AREA 3)

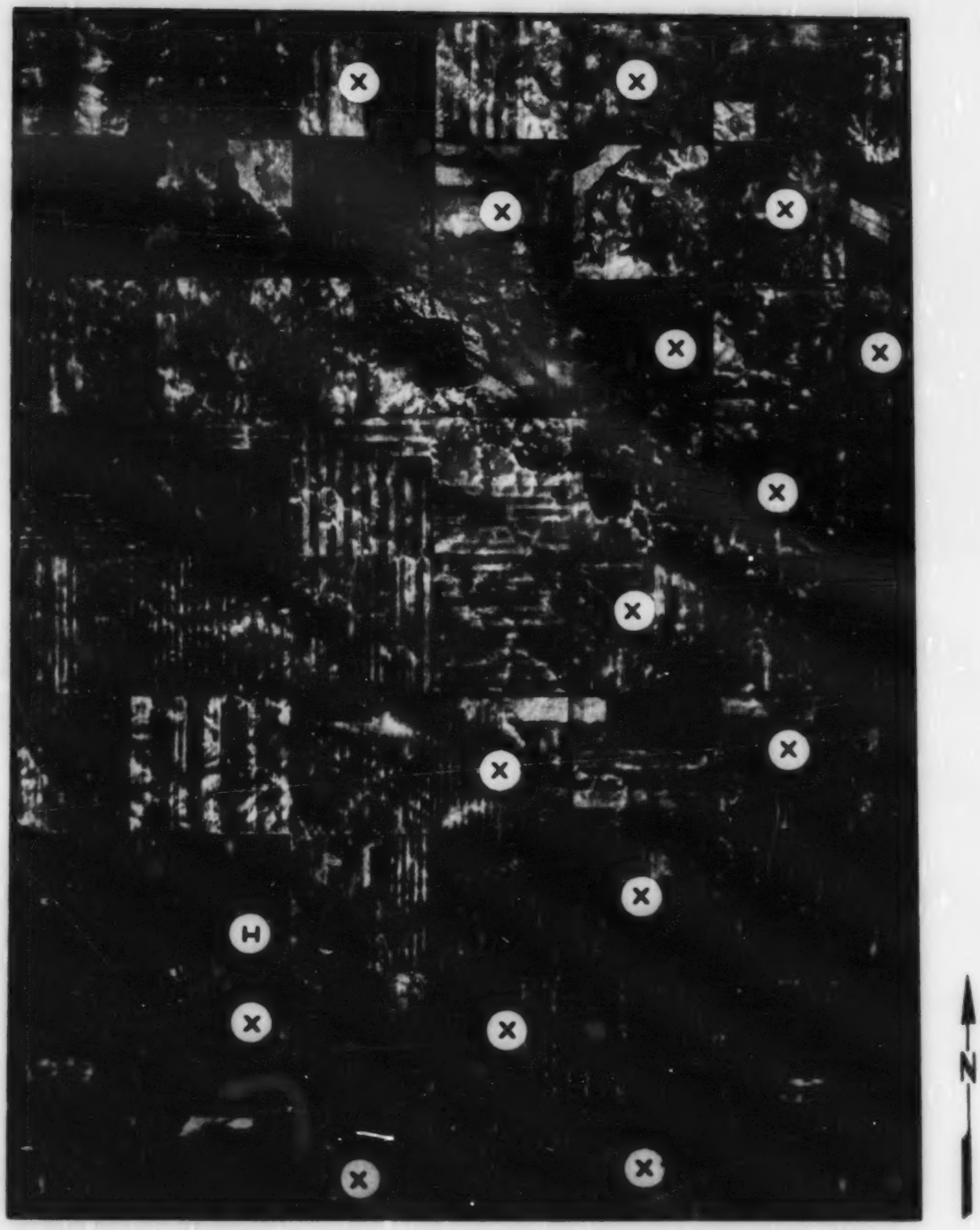


PLATE 12 BUFFALO CREEK (AREA 3)

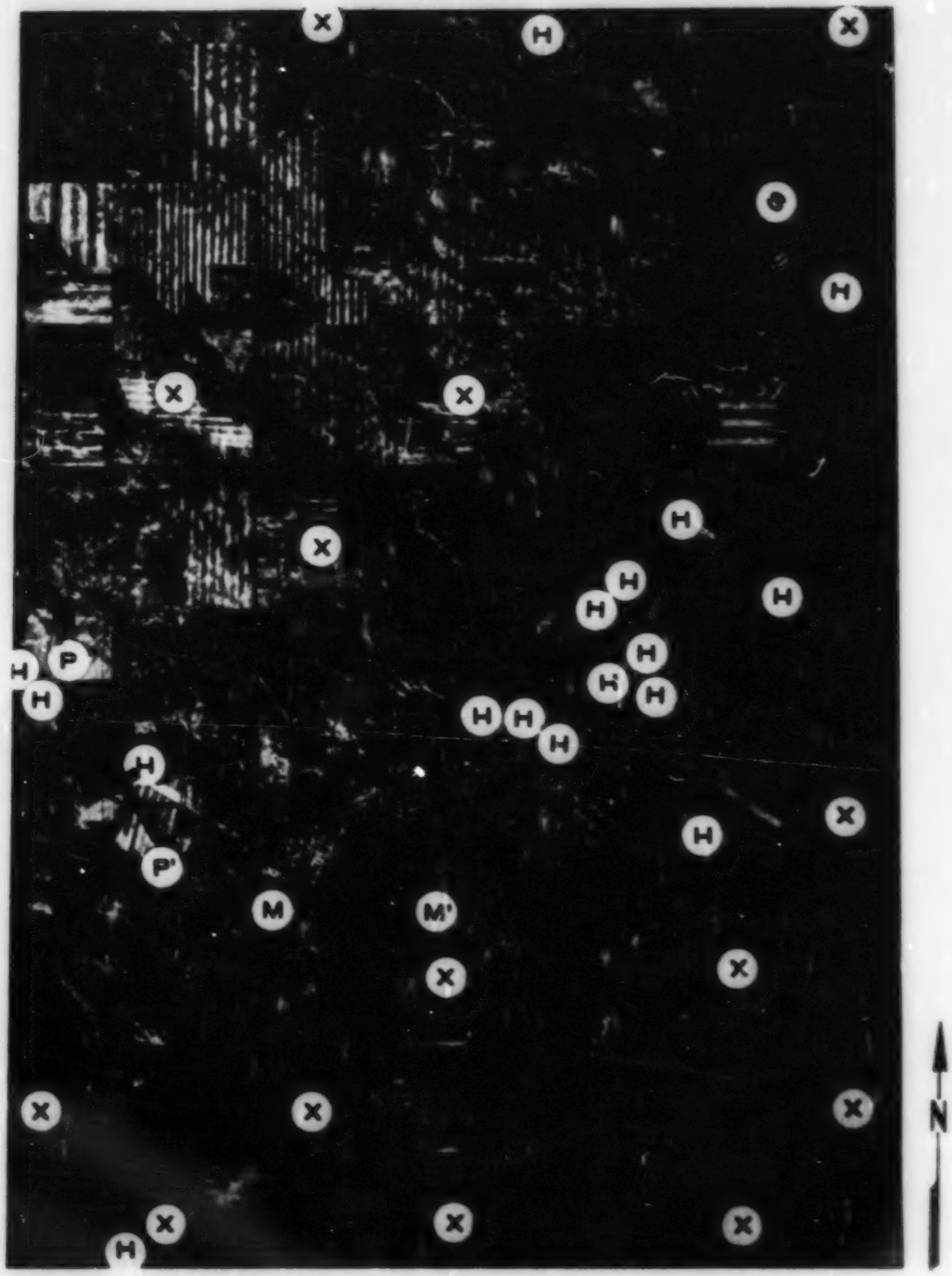

X
H
X
H
X
X
H
X
H
H
H
H
H
H
P
H
H
H
H
H
H
H
X
P'
M
M'
X
X
X
X
X
X
H
X
X
N

PLATE 13 LOST AND BUFFALO SPRINGS CREEKS (AREA 3)

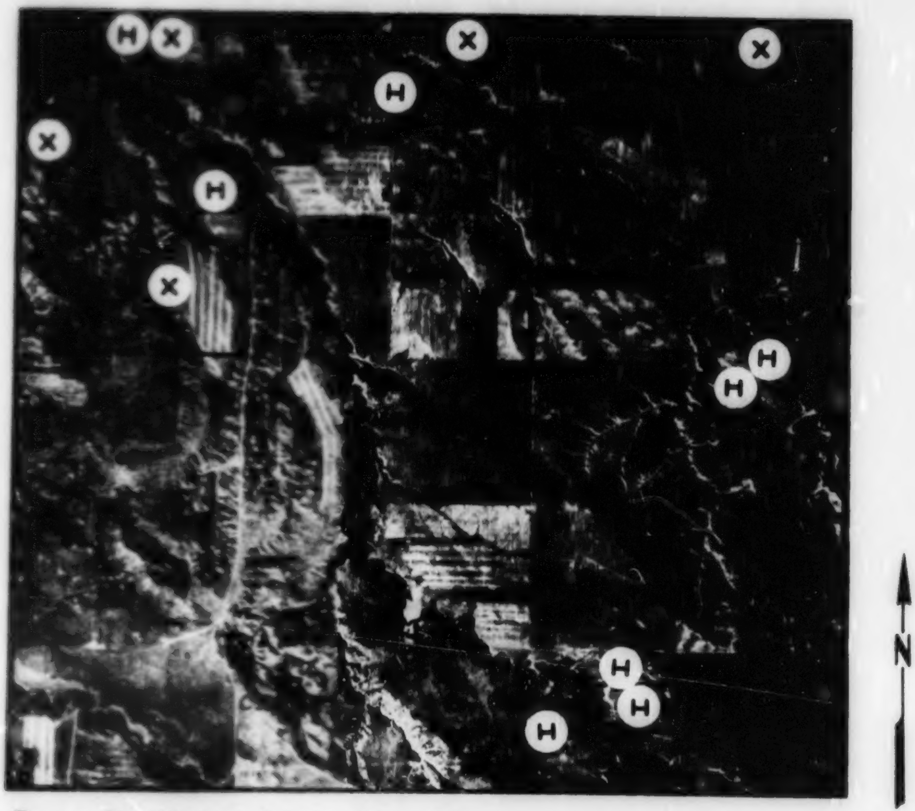

H
X
X
H
X
X
H
X
H
H
H
H
H
N

Plate 14 McCune Creek (Area 3)

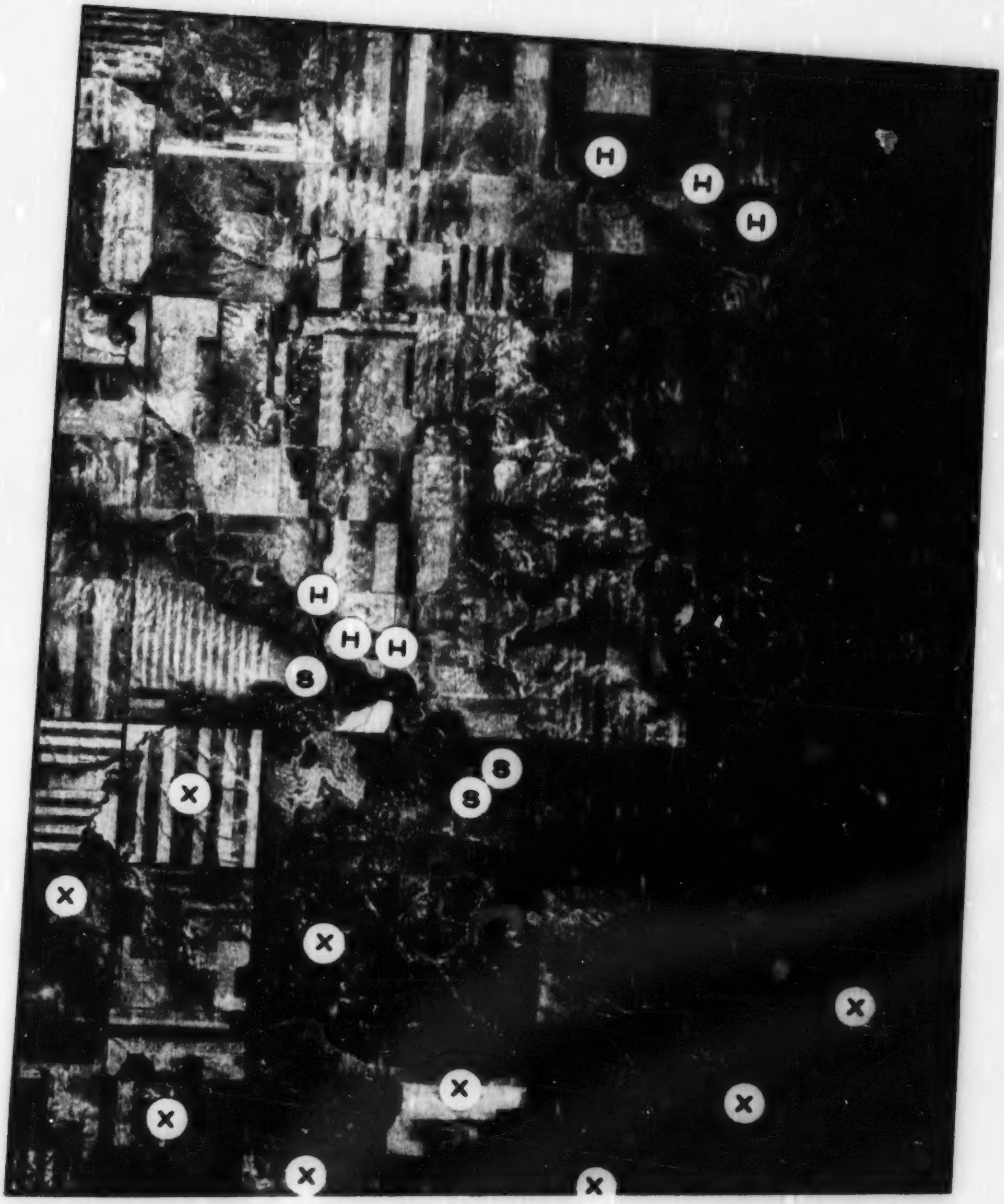

H
H
H
H
H
H
S
S
S
X
X
X
X
X
X
X
X
X

PLATE 15 COW CREEK EAST (AREA 3)

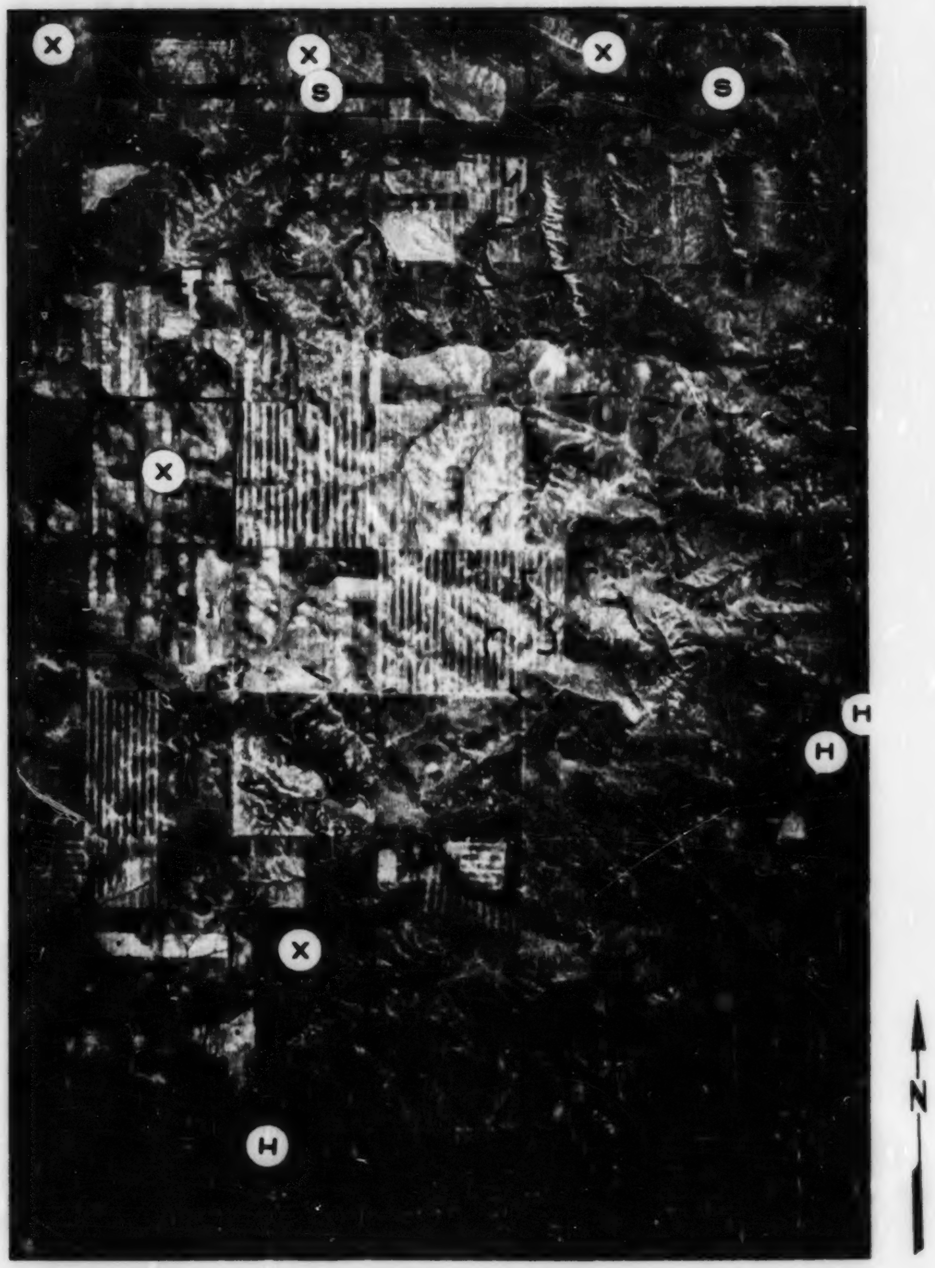

X
X
S
X
S
X
H
H
X
H
N

PLATE 16 DUCK AND SPRING CREEKS (AREA 3)

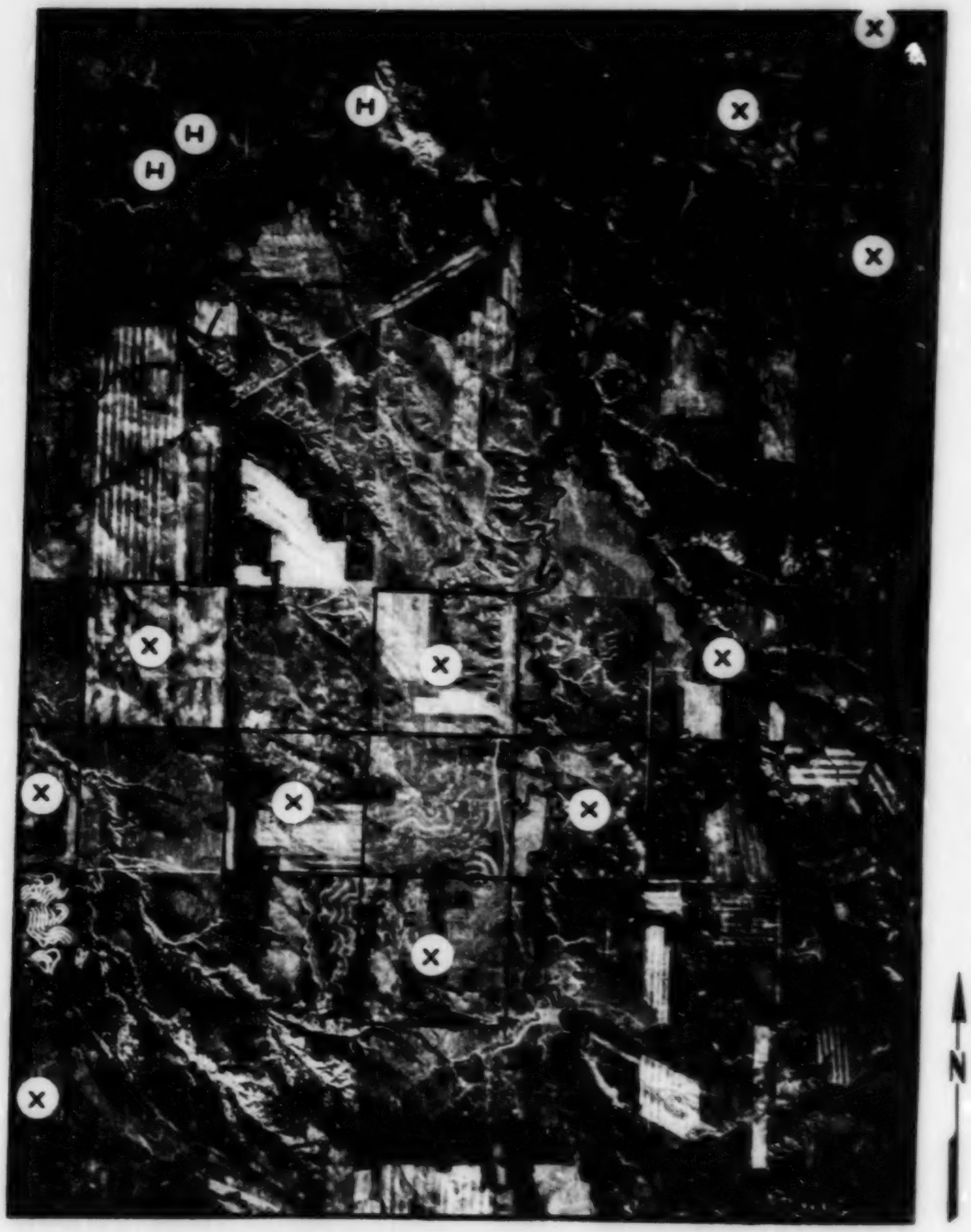

H
H
H
X
X
X
X
X
X
X
X
X
X
X
N

PLATE 17 COTTONWOOD CREEK (AREA 3)

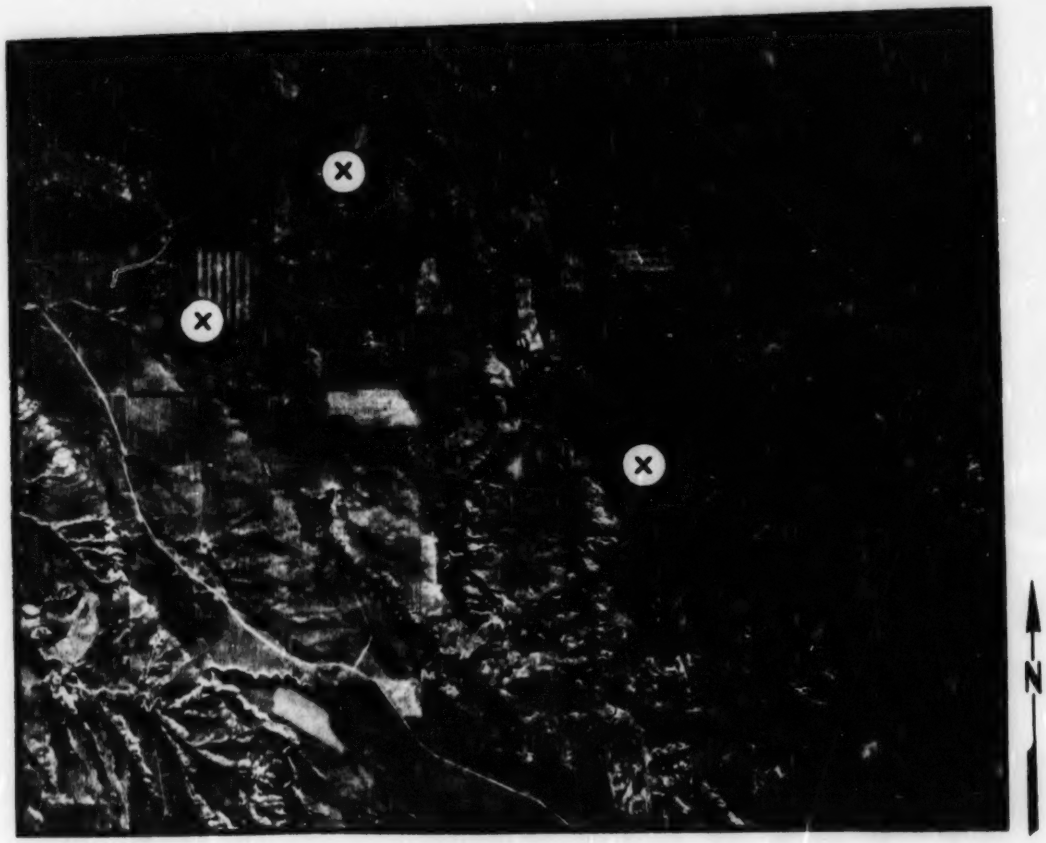


PLATE 18 BERRY CREEK (AREA 3)

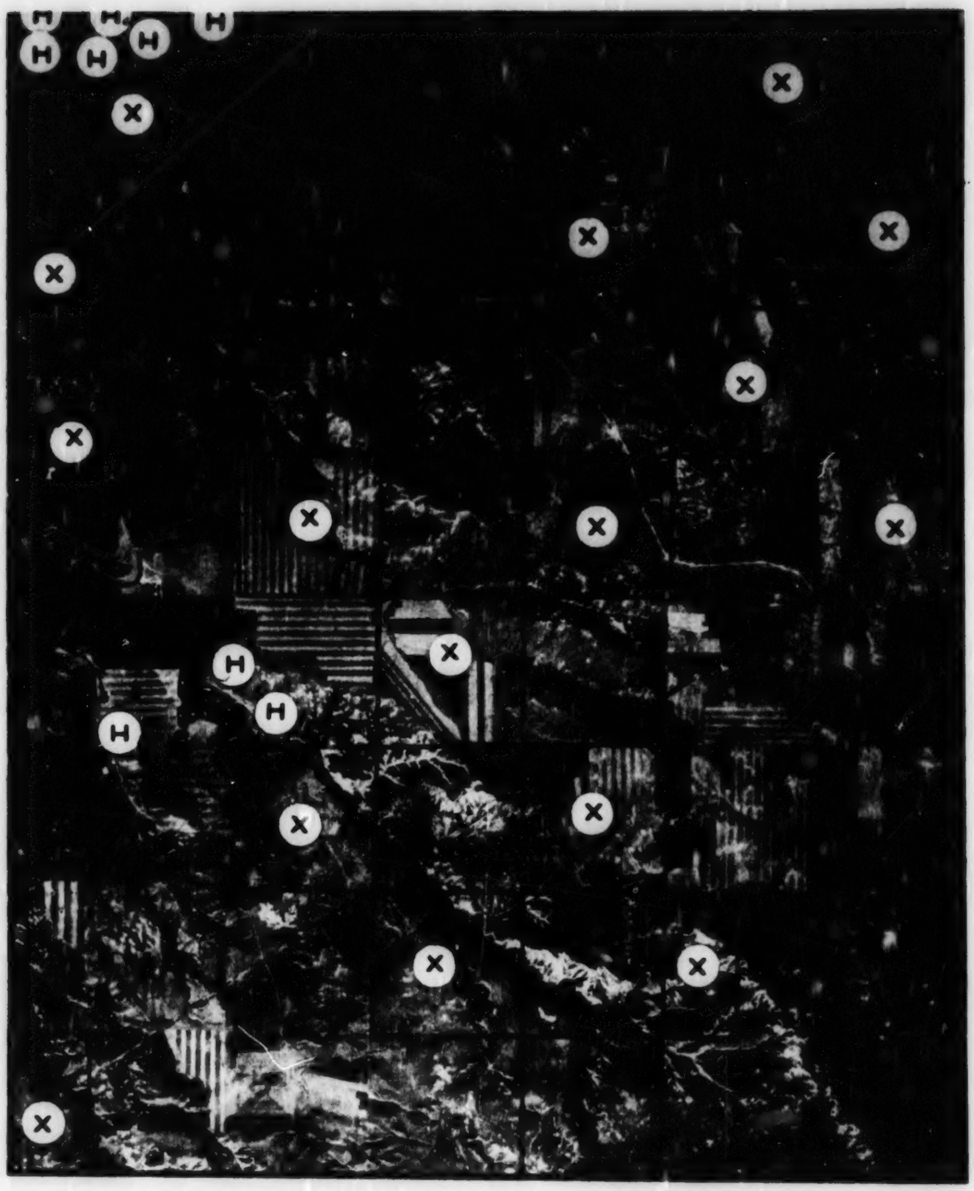
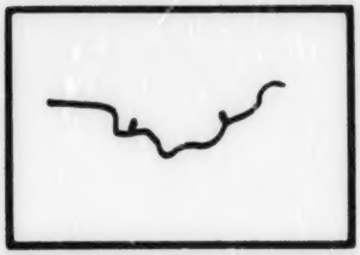


PLATE 19 BLUFF CREEK (AREA 3)

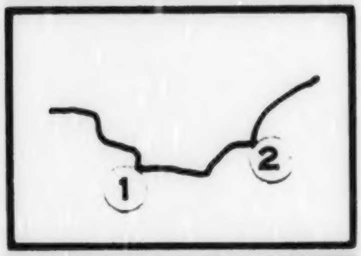
TRANSECTS

Transects M - M' through P - P'   Redwater River Deposit

Legend

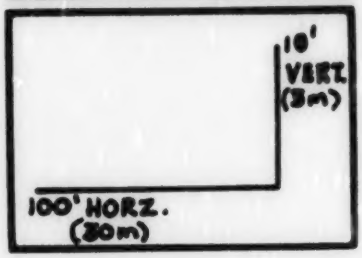


Highest evidence of flood flow (where found) indicated by fiducary marks on either side of channel.



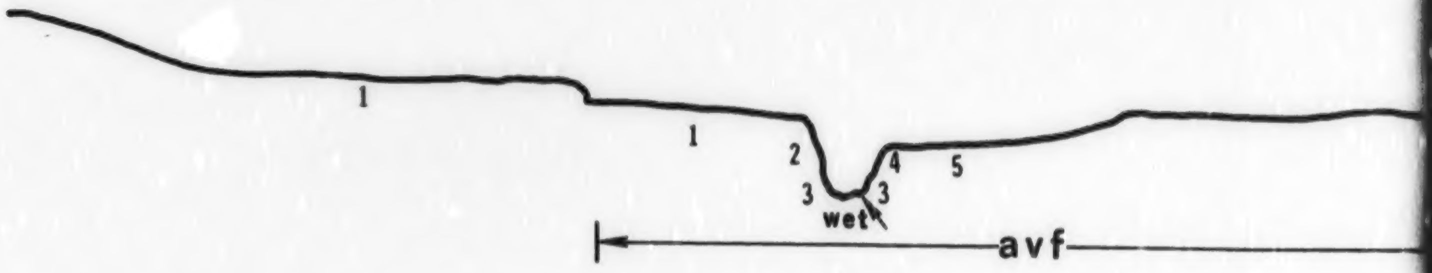
Location of vegetation survey. Observations below transect are in terms of percent of total vegetative cover each species comprises. Descriptions are for a band fifteen meters wide along transect.

(transects based on pace and compass measurements, not surveys)



Scale

M



1	blue grama	75%
	western wheatgrass	25%
	silver sagebrush	T-40%
	needle-and-thread	T
	curlycup gumweed	T
	cudweed sagewort	T
	hairy golden aster	T

2	canada wild rye	40%
	Kentucky bluegrass	30%
	yellow sweetclover	20%
	switch panicgrass	10%
	fringed sagewort	T
	wild licorice	T
	rose	T
	cudweed sagewort	T
	crested wheatgrass	T

3	baltic rush	90%
	switch panicgrass	T

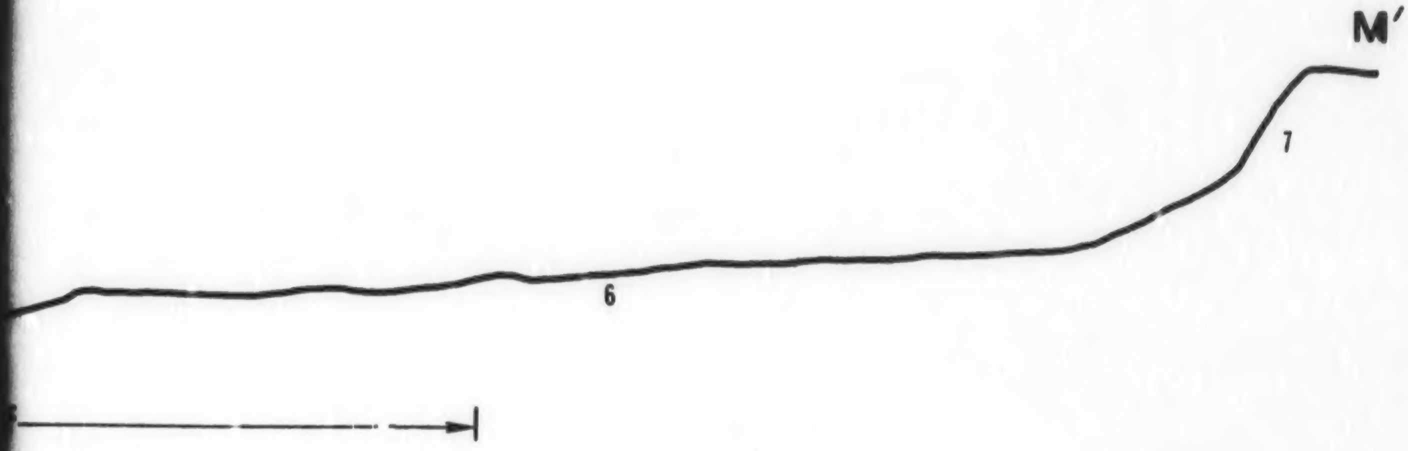
4	Canada wildrye	65%
	slender wheatgrass	20%
	switch panicgrass	10%
	prairie cordgrass	T
	horsetail	T
	wild licorice	T

5	prairie sand reedgrass	60%
	western wheatgrass	25%
	yellow sweetclover	5%
	switch panicgrass	3%
	wild licorice	T
	cudweed sagewort	T
	woods rose	T
	Canada wildrye	T
	Kentucky bluegrass	T

6 western wheatgrass
silver sagebrush
prairie sand reedgra
blue grama
needle-and-thread
woods rose
fringed sagewort
clubmoss
broom snakeweed
hairy golden aster
yellow sweetclover
common snowberry

7 blue grama grass
western wheatgrass
silver sagebrush
broom snakeweed
hairy golden aster
fringed sagewort
clubmoss
yellow sweetclover

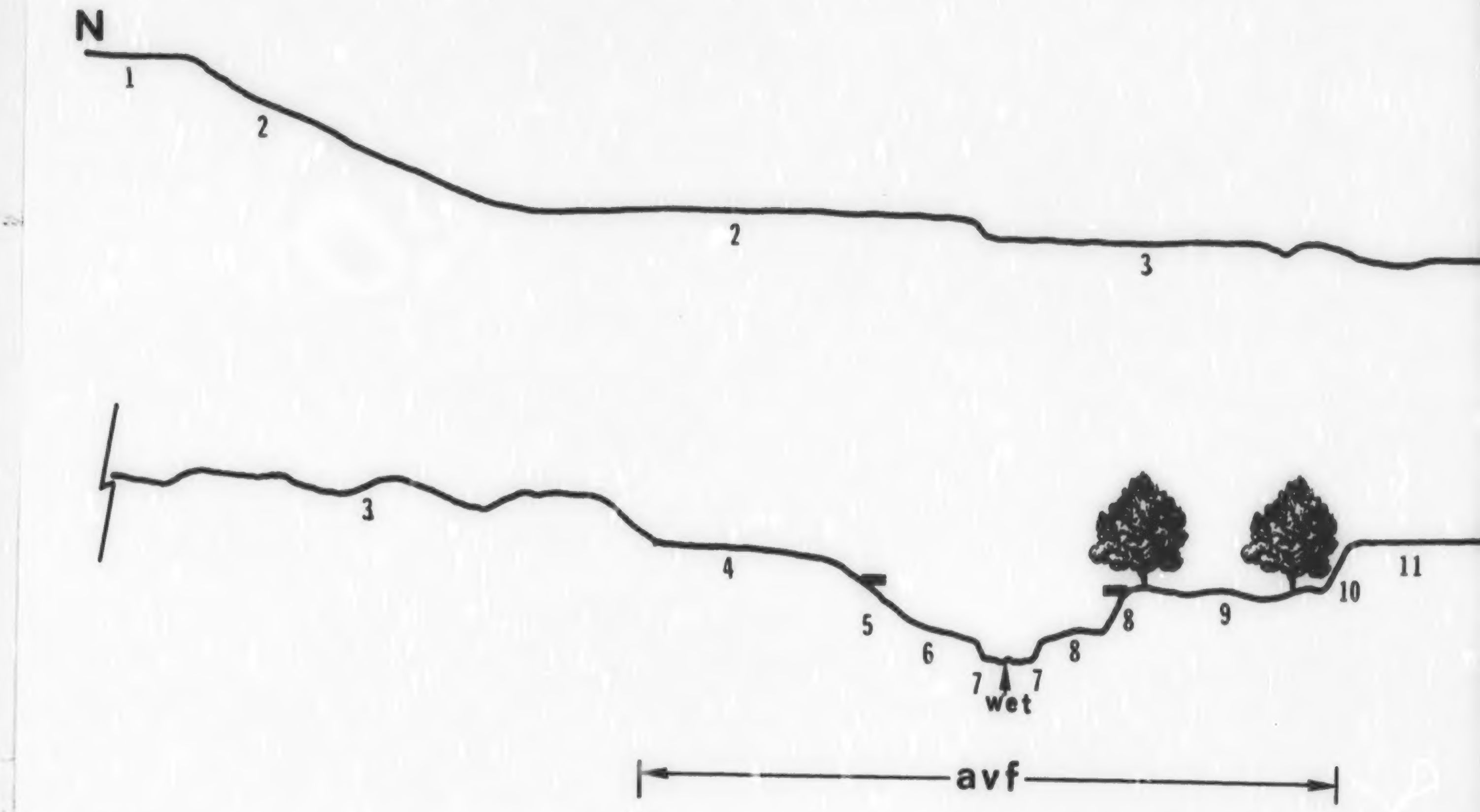
Location shown on Plate 13
Lost and Buffalo Springs Creeks



6	western wheatgrass	45%
	silver sagebrush	20%
	prairie sand reedgrass	15%
	blue grama	10%
	needle-and-thread	5%
	woods rose	T
	fringed sagewort	T
	clubmoss	T
	broom snakeweed	T
	hairy golden aster	T
	yellow sweetclover	T
	common snowberry	T

7	blue grama grass	40%
	western wheatgrass	25%
	silver sagebrush	T
	broom snakeweed	T
	hairy golden aster	T
	fringed sagewort	T
	clubmoss	T
	yellow sweetclover	T

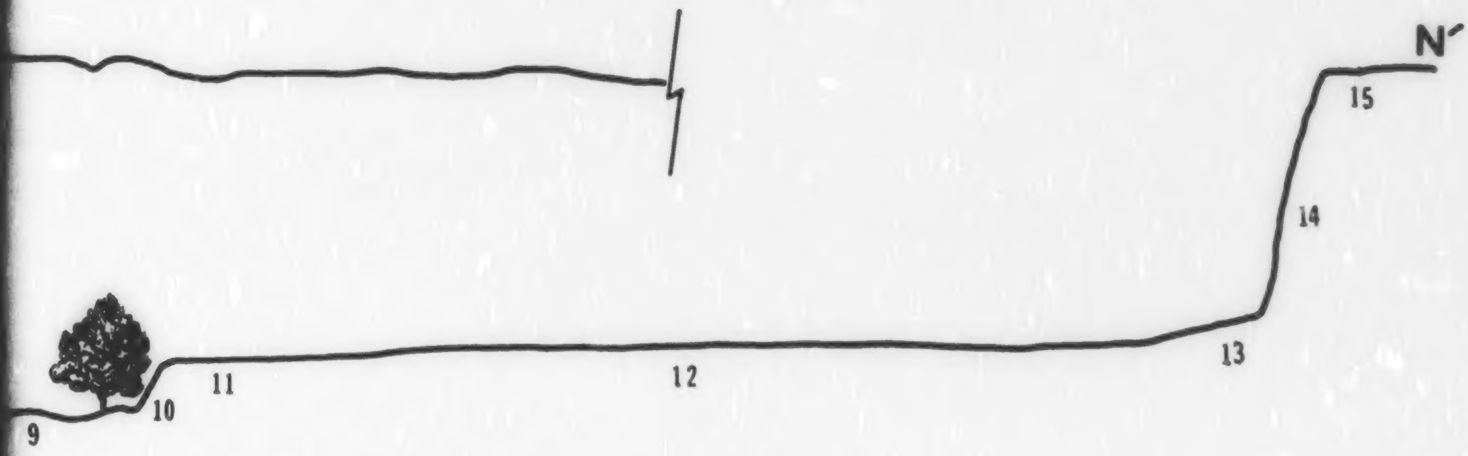
FIGURE 30
REDWATER RIVER



1	wheat	
2	crested wheatgrass	70%
	blue grama	20%
	needle-and-thread	5-8%
	western wheatgrass	T
3	(high areas)	
	blue grama	70%
	western wheatgrass	20%
	needle-and-thread	10%
	silver sagebrush	T
3	(low areas)	
	prairie sand reedgrass	50%
	blue grama	20%
	needle-and-thread	20%
	western wheatgrass	10%
	little bluestem	T
	crested wheatgrass	T
	horsetail	T
4	blue grama	40%
	needle-and-thread	30%
	prairie sand reedgrass	30%
	horsetail	T
	switch panicgrass	T
	crested wheatgrass	T
	silver sagebrush	T
5	prairie sand reedgrass	70%
	yellow sweet clover	25%
	crested wheatgrass	T
	silver sagebrush	T
	blue grama	T
	horsetail	T
6	yellow sweetclover	80%
	switch panicgrass	10%
	slender wheatgrass	10%
7	baltic rush	95%
8	switch panicgrass	
	Kentucky bluegrass	
	prairie sand reedgrass	
	yellow sweet clover	10-
	canada wildrye	
	common snowberry	
9	crested wheatgrass	1
	Kentucky bluegrass	
	silver sagebrush	
	cudweed sagewort	
10	prairie sand reedgrass	
	Kentucky bluegrass	
	blue grama	
	western wheatgrass	
	silver sagebrush	
	crested wheatgrass	
	cudweed sagewort	

Location shown on Plate 10

Timber and Dry Ash Creeks



tch panicgrass	40%
tucky bluegrass	25%
irie sand reedgrass	20%
low sweet clover	10-15%
ada wildrye	T
mon snowberry	T

sted wheatgrass	100%
tucky bluegrass	T
ver sagebrush	T
weed sagewort	T

irie sand reedgrass	25%
tucky bluegrass	20%
grama	20%
tern wheatgrass	15%
ver sagebrush	10%
sted wheatgrass	10%
eed sagewort	T

11	blue grama	100%
	fringed sagewort	T
	silver sagebrush	T

12	wheat	

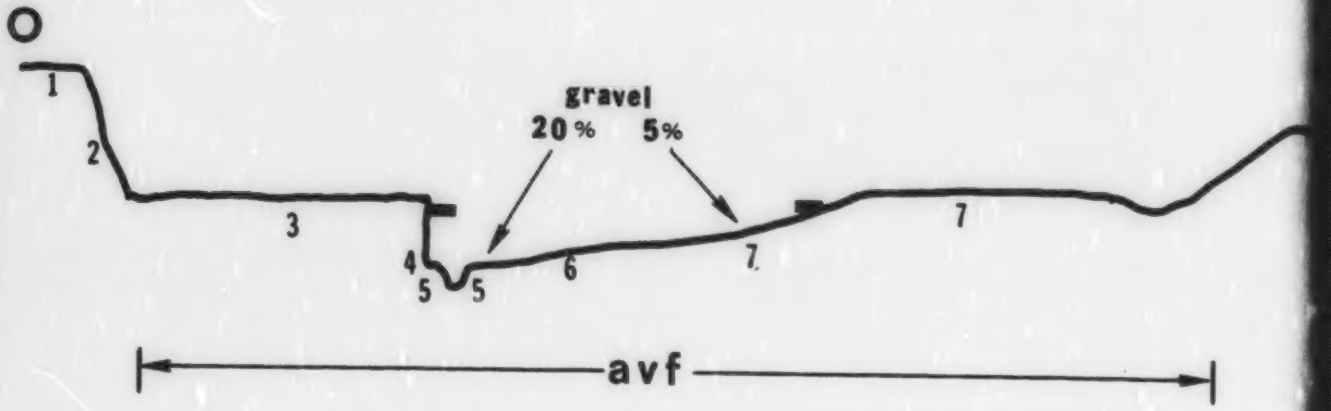
13	crested wheatgrass	95%
	blue grama	5%
	silver sagebrush	T

14	western wheatgrass	35%
	crested wheatgrass	25%
	silver sagebrush	15%
	common snowberry	10%
	needle-and-thread	10%
	green needlegrass	T
	broom snakeweed	T

15	blue grama	50%
	western wheatgrass	50%
	dropseed	T
	crested wheatgrass	T
	silver sagebrush	T
	fringed sagewort	T
	needle-and-thread	T
	broom snakeweed	T
	slender wheatgrass	T
	rubber rabbitbrush	T

FIGURE 31

REDWATER RIVER



1	needle-and-thread	75%
	blue grama	25%
	silver sagebrush	T-5%

2	needle-and-thread	80%
	blue grama	10%
	cudweed sagewort	5%
	silver sagebrush	2-3%
	yellow sweetclover	T
	horsetail	T

3	western wheatgrass	60%
	needle-and-thread	30%
	silver sagebrush	5%
	Kentucky bluegrass	T
	sandberg bluegrass	T
	fringed sandwort	T

4	Kentucky bluegrass	75%
	inland saltgrass	25%
	horsetail	T
	yellow sweetclover	T
	slender wheatgrass	T
	silver sagebrush	T
	switch panicgrass	T
	canada wildrye	T

5	baltic rush	90%
	slender wheatgrass	T
	curlycup gumweed	T
	prairie cordgrass	T

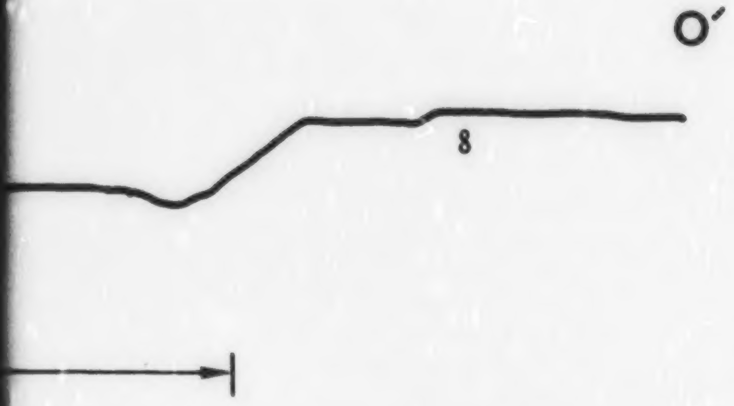
6	inland saltgrass	45%
	needle-and-thread	35%
	yellow sweetclover	20%
	silver sagebrush	T
	switch panicgrass	T

7	blue
	needl
	weste
	prai
	silv

8	blue
	needl
	weste
	silv

Location shown on Plate 10

Timber and Dry Ash Areeks



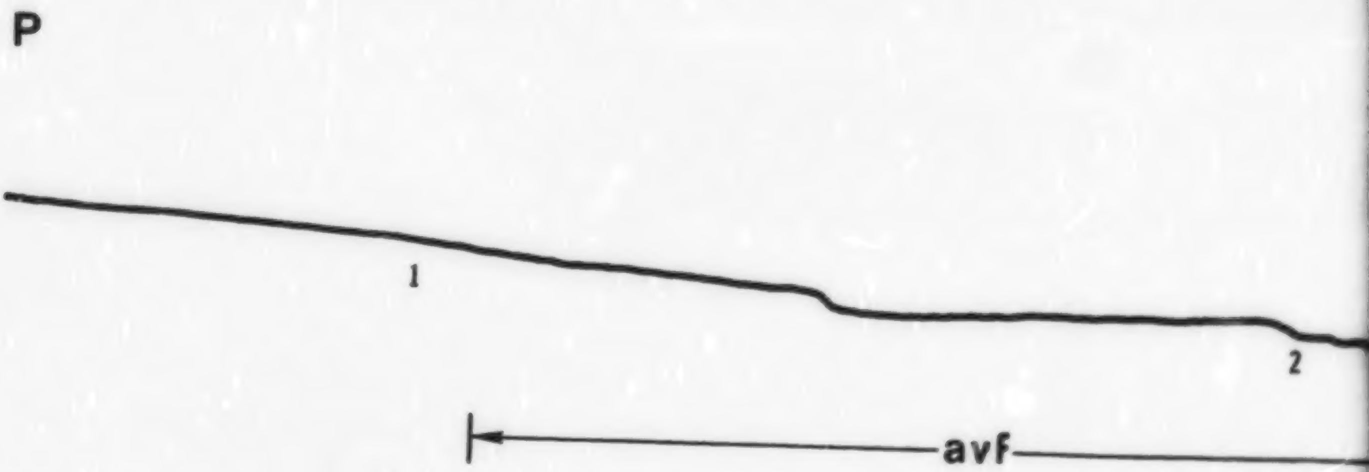
5%
5%
T
T
T
T
T
T

0%
T
T
T

5%
5%
0%
T
T

7	blue grama	50%
	needle-and-thread	30%
	western wheatgrass	10%
	prairie sand reedgrass	10%
	silver sagebrush	3%
8	blue grama	80%
	needle-and-thread	20%
	western wheatgrass	T
	silver sagebrush	T

FIGURE 32
REDWATER RIVER



1	blue grama	90%
	inland saltgrass	7%
	western wheatgrass	3%

2	inland saltgrass	95%
	western wheatgrass	T

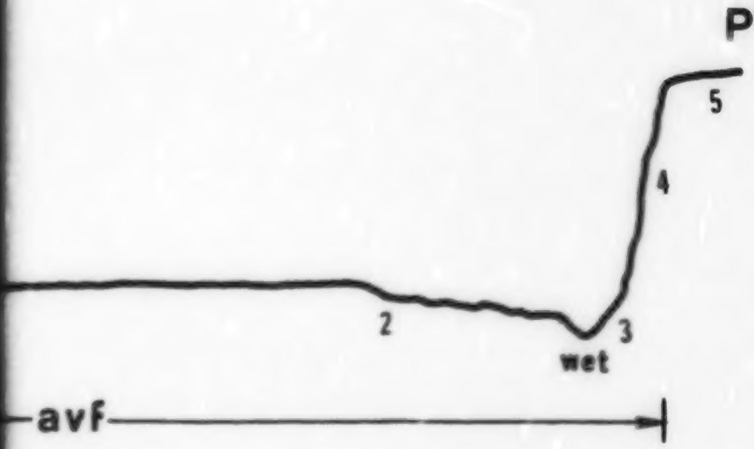
3	inland saltgrass	80%
	blue grama	10%
	wild licorice	T
	switch panicgrass	T
	silver sagebrush	T
	slender wheatgrass	T
	Kentucky bluegrass	T
	sedges	T

4	blue grama	50%
	needle-and-thread	25-30%
	western wheatgrass	20%
	silver sagebrush	T-3%
	broom snakeweed	T
	woods rose	T
	buffaloberry	T
	fringed sagewort	T
	curlycup gumweed	T
	plains prickly pear	T

5	blue grama	90%
	western wheatgrass	5%
	needle-and-thread	2-3%
	silver sagebrush	T
	broom snakeweed	T
	fringed sagewort	T
	plains prickly pear	T

Location shown on Plate 13

Lost and Buffalo Springs Creeks



	50%
read	25-30%
tgrass	20%
ush	T-3%
ed	T
	T
	T
ort	T
eed	T
y pear	T

	90%
grass	5%
read	2-3%
ush	T
ed	T
ort	T
y pear	T

FIGURE 33
HORSE CREEK

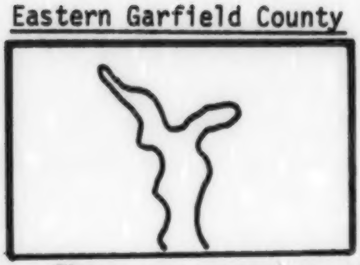
APPENDIX IV

Area 4. Eastern Garfield County

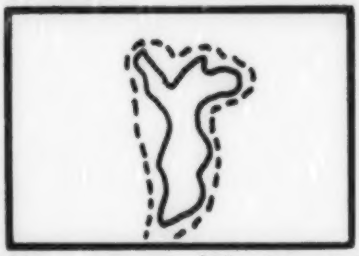
LEGEND

1:24,000 topographic maps
(Figures 14-17)

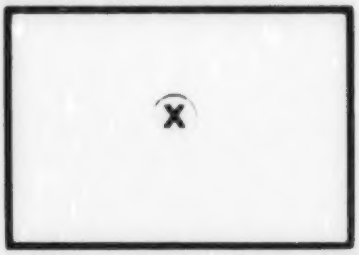
Eastern Garfield County



Alluvial Valley Floors. These are mapped as the low terrace, floodplain, and channel of major drainages and those minor drainages whose low terraces are either used in part for hay production or which have the potential for such use. These areas may include soils which have potential salinity problems. Areas less than 15 m excluded.



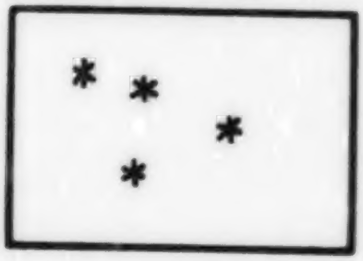
Related Alluvial Deposits. Recent (?) alluvial deposits of streams whose lowest terraces are mapped as alluvial valley floors. Includes surface colluvium probably underlain by alluvium.



Nominated BLM Lands for Coal Leasing (BLM, 1976). Lands nominated in 1976 for leasing by Bureau of Land Management for coal development.

Hayed Lands. Lands where hay was observed to be harvested and lands irrigated for that purpose. Irrigated lands mapped by the Montana Water Resources Board (unpublished).

Salt Crusts. Surface salt crust observed in field or on air photos.



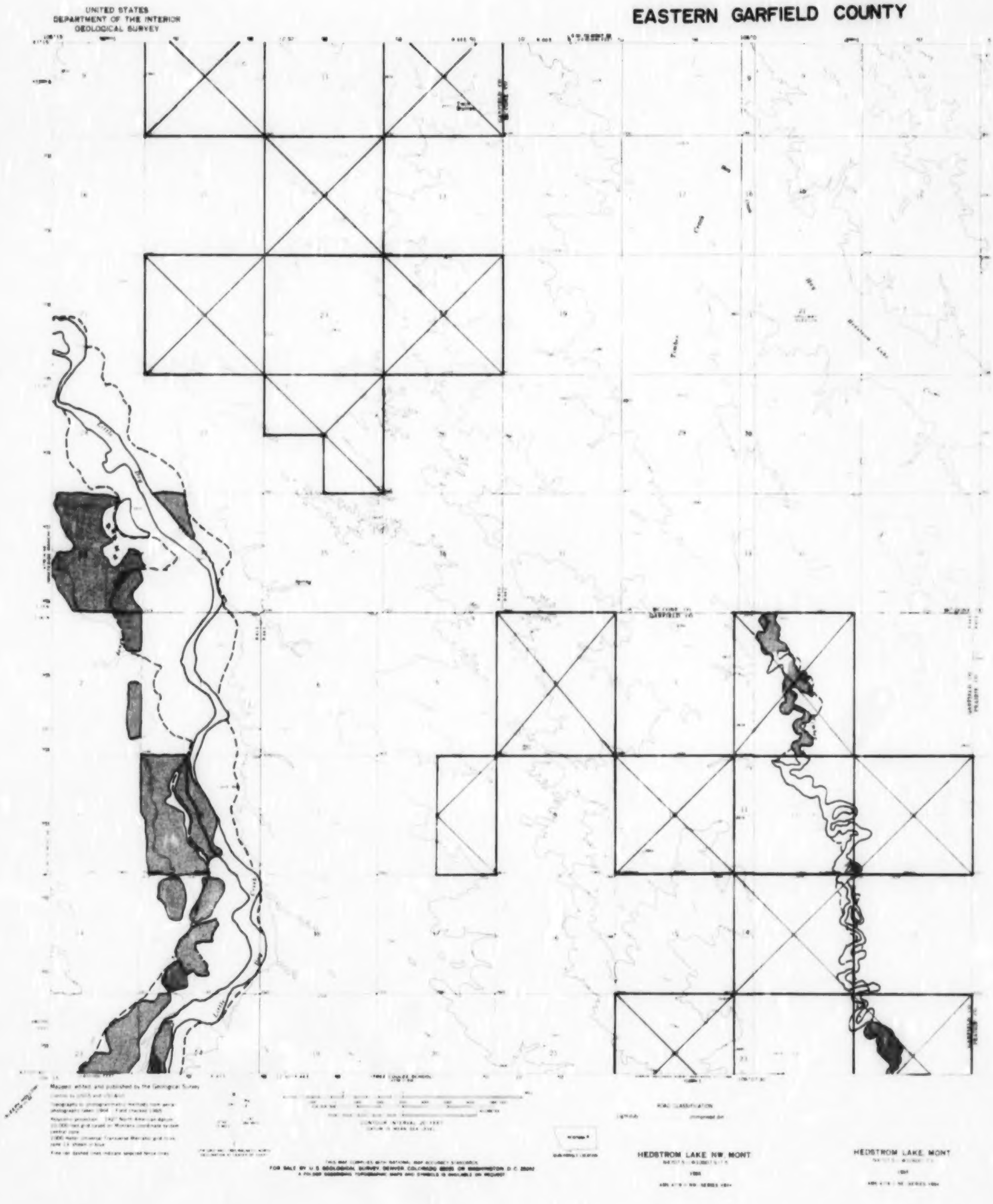

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
EASTERN GARFIELD COUNTY
HEDSTROM LAKE NW, MONT
HEDSTROM LAKE, MONT

FIG. 14 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
HEDSTROM LAKE NW AND HEDSTROM LAKE QUADRANGLES, MT

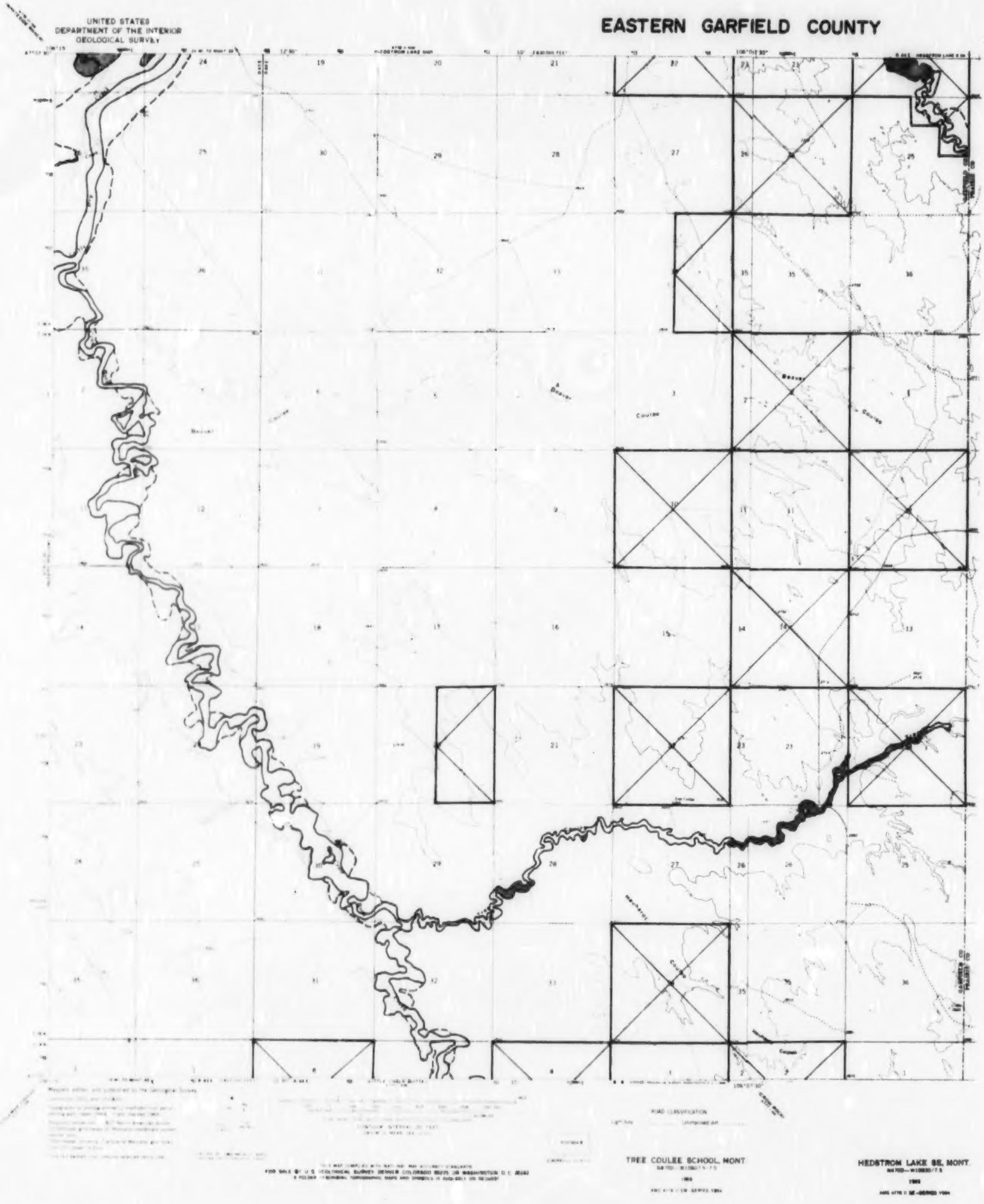

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
EASTERN GARFIELD COUNTY
Beaver
Coulee
ROAD CLASSIFICATION
TREE COULEE SCHOOL, MONT
HEDSTROM LAKE SE, MONT

FIG. 15 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES TREE COULEE SCHOOL AND HEDSTROM LAKE SE QUADRANGLES, MT

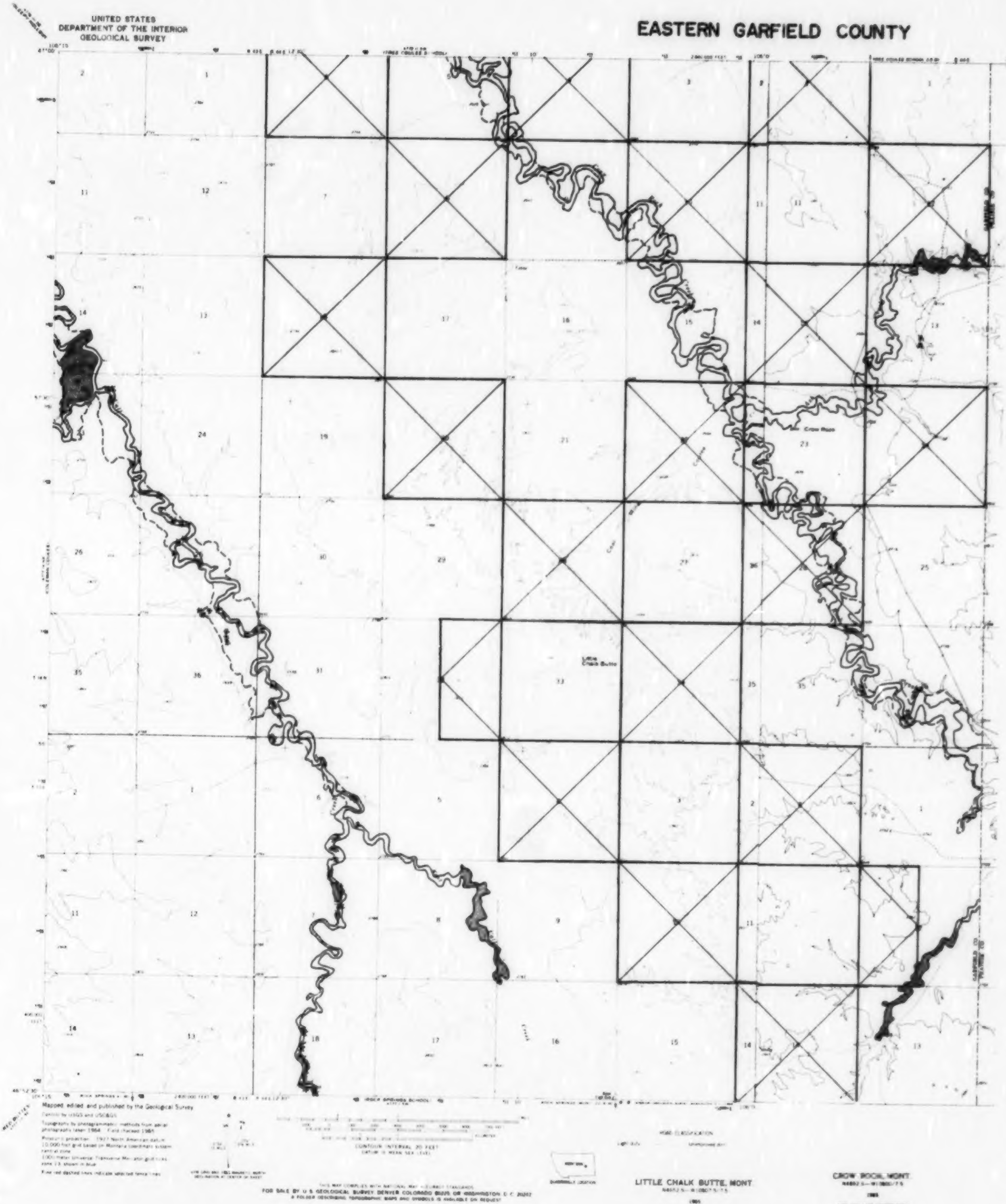

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
EASTERN GARFIELD COUNTY
Crow Rock
Little Chalk Butte
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
ROAD CLASSIFICATION
QUADRANGLE LOCATION
LITTLE CHALK BUTTE, MONT.
CROW ROCK, MONT.
Mapped, edited, and published by the Geological Survey
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR WASHINGTON, D.C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

FIG. 16 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES LITTLE CHALK BUTTE AND CROW ROCK QUADRANGLES, MT

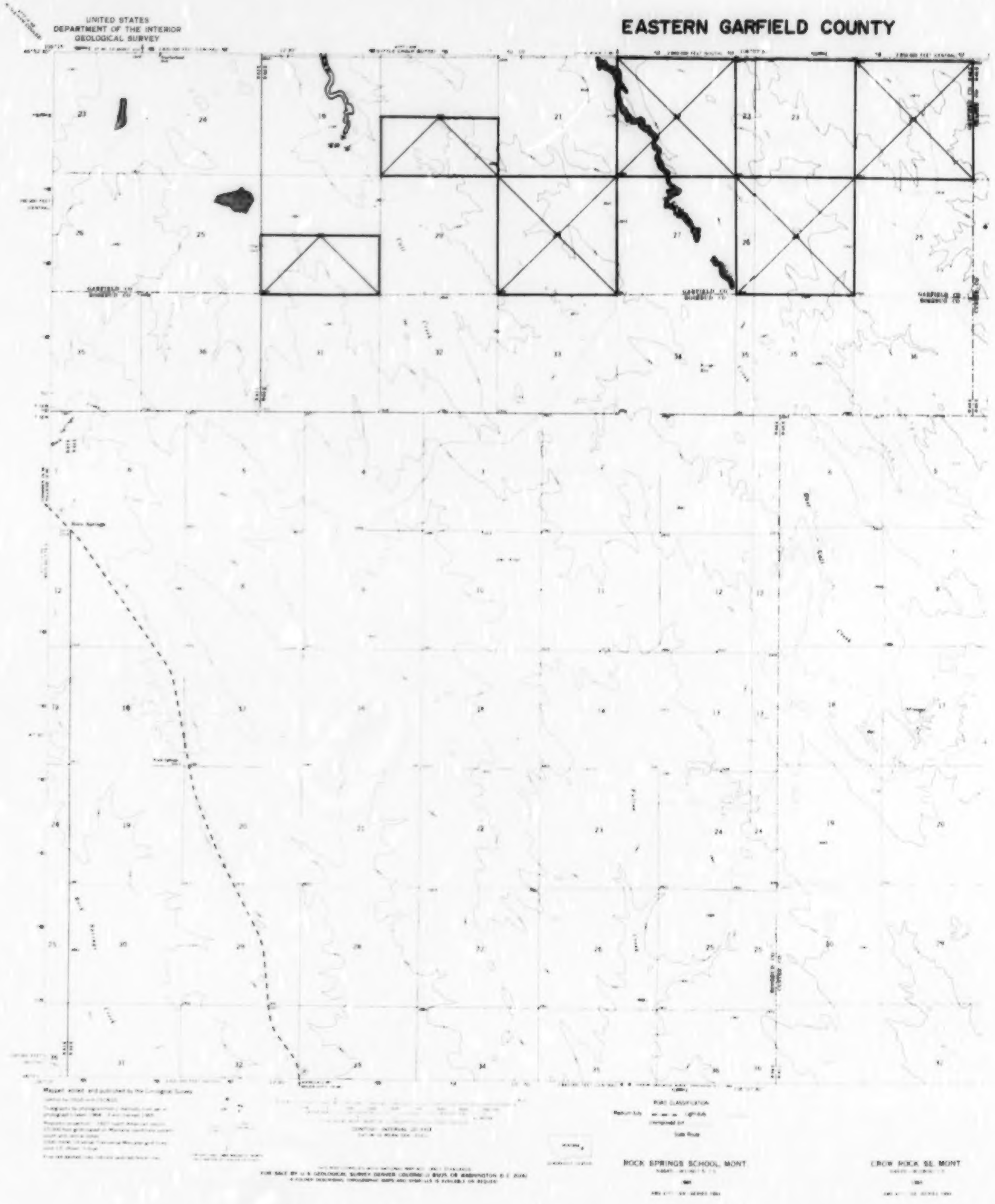

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
EASTERN GARFIELD COUNTY
GARFIELD CO.
ROSEBUD CO.
ROCK SPRINGS SCHOOL, MONT.
CROW ROCK SE, MONT.

FIG. 17 LOCATION OF ALLUVIAL VALLEY FLOORS AND RELATED FEATURES
ROCK SPRINGS SCHOOL AND CROW ROCK SE QUADRANGLES, MT

COMMON AND SCIENTIFIC NAMES OF VEGETATION FOUND IN STUDY AREAS*

Alkali cordgrass	*Apartina gracilis*
Alkali sacaton	*Sporobolus airoides*
Alkaligrass	*Pucinellia airoides*
American bullrush	*Scirpus americanus*
American sloughgrass	*Beckmannia syzigachne*
American vetch	*Vicia americana*
Baltic rush	*Juncus balticus*
Big bluestem	*Andropogon gerardii*
Blue flax	*Linum perenne*
Blue grama	*Boutelous gracilis*
Bluegrass	*Poa* spp.
Broom snakeweed	*Gutierrezia sarothrae*
Buffaloberry	*Sheperdia argentea*
Canada wildrye	*Elymus canadensis*
Cheatgrass brome	*Bromus tectorum*
Clubmoss	*Lycopodium*
Common dandelion	*Taraxacum officinale*
Common milkweed	*Asclepius syriaca*
Common salsify	*Tragopagon dubius*
Common sixweeksgrass	*Vulpia octoflora*
Common snowberry	*Symphoricarpus albus*
Cordgrass	*Spartina* spp.
Creeping juniper	*Juniperus horizontalis*
Crested wheatgrass	*Agropyron cristatum*
Cudweed sagewort	*Artemesia ludoviciana*
Curly dock	*Rumex crispus*
Curlycup gumweed	*Grindelis squarrosa*
Dropseed	*Sporobolus* spp.
Fescue	*Festuca* spp.
Foxtail barley	*Hordeum jubatum*
Fringed sagewort	*Artemesia frigida*
Goosefoot	Chenopodiaceae
Green bristlygrass	*Setaris viridis*
Hairy golden aster	*Chrysopsis villosa*
Horsetail	*Equisetum* spp.
Indian ricegrass	*Oryzopsis hymenoides*
Inland saltgrass	*Distichlis stricta*
Junegrass	*Koeleria cristata*
Juniper	*Juniperus* spp.
Kentucky bluegrass	*Poa pretensis*
Kochia	*Kochia scoparia*
Little bluestem	*Andropogon scoparius*
Mustard	Cruciferae
Nuttall Saltbush	*Atriplex nuttallii*

---

* Booth, W. E. 1972. Grasses of Montana. Montana State University, Boseman, MT. 305pp.

Booth, W.E. and J.C. Wright. 1966. Flora of Montana, dicotyledons. Montana State University, Bozeman, MT. 305pp.

Prairie cordgrass	*Spartina pectinata*
Prairie sand reedgrass	*Calamovilfa longifolia*
Pussytoes	*Antennaria* spp.
Quackgrass	*Agropyron repens*
Red threeawn	*Aristada longiseta*
Reed canarygrass	*Phalaris arundinacea*
Rough false pennyroyal	*Hedeoma hispida*
Rubber rabbitbrush	*Chrysothamnus nauseosus*
Rushes	*Juncus* spp.
Sandberg bluegrass	*Poa secunda*
Scarlet globemallow	*Sphaeralcae coccinea*
Sedge	*Carex* spp.
Sideoats grama	*Bouteloua curtipendula*
Silver sagebrush	*Artemesia cana*
Slender wheatgrass	*Agrpyron trachycaulum*
Small leaf pussytoes	*Antennaria parviflora*
Smooth brome	*Bromus inermis*
Squirreltail	*Sitanion hystrix*
Stillstem flax	*Linum rigidum*
Sunflower	*Helianthus* spp.
Switch panicgrass	*Panicum virgatum*
Thimothy	*Phleum pratensis*
Thistle	*Carduus* spp.
Treadleaf sedge	*Carex fillifolia*
Tumble grass	*Schedonnardus paniculatis*
Western wheatgrass	*Agropyron smithii*
Western yarrow	*Achillea lanulosa*
White milkwort	*Polygala alba*
Wild licorice	*Glycyrrhiza lipidota*
Willow	*Salix* spp.
Woods rose	*Rosa woodsii*
Yellow sweetclover	*Melilotus officinalis*
Yucca	*Yucca* spp.

alluvial valley floors in the Burns Creek-Thirteenmile Creek KCLA and the Redwater River deposit show that about twice as much coal underlies the total alluvial deposit area than underlies the more restrictively defined alluvial valley floor. If mining were excluded in the total alluvial valley floor area, an even greater percentage of reserves would be made unavailable because of the impracticality of developing logical mining units. Despite this fact, extensive strippable coal reserves exist in each area studied in this report, outside of valley floor areas.

Various characteristics of valley floor areas were mapped and vegetation was investigated along several transects in the Burns Creek-Thirteenmile Creek KCLA and in the Redwater River area. These data show that valley floors support distinctive vegetative communities (species lists are included in the report) and produce the most forage of any range sites in the area. Soil salinity is the most important factor limiting use of valley floors, particularly in McCone and eastern Garfield Counties, and also may pose a significant challenge to mining reclamation.

This work supports conclusions of previous investigations in demonstrating that the quasi land use category of alluvial valley floors can be mapped by combining topographic maps, selected aerial photography, and reconnaisance field work. This work identifies the alluvial valley floor as a part of a larger mappable geologic unit which includes the alluvial deposits extending out from the alluvial valley floors and

While it remains evident that more detailed hydrologic, geologic, and engineering work is necessary to identify the specific impacts of a mining operation on a particular valley floor, this effort shows that it is possible to use reconnaissance methods to identify and map those valley floors of agriculture and hydrologic significance. Future reconnaissance mapping efforts should focus on valleys used in part for hay production since most all alluvial valley floors mapped in this study contain some areas of hay production. It is estimated that 25 percent of all mapped alluvial valley floors were in hay production at the time of the field investigations. Those areas mapped as related alluvial deposits included most of the remaining hay lands.

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☆ U.S. Government Printing Office: 1977-778-495/134 Region 8